

Dentine Graft: A Substitute For Bone Grafts In Oral Implantology. A Literature Review

Bhupender Kumar Yadav*, Abhishek Nagpal*, Reshu Madan*, Omkar Shetty*, Jaiveer yadav*, Kunal Nischal*

***Department of prosthodontics, Faculty of Dental sciences, SGT University**

For Correspondence: Dr. Abhishek Nagpal

Department of Prosthodontics

Mob No: 9999990098

Email id: abhishek_fdsc@sgtuniversity.org

Abstract:

Tooth extraction and immediate placement of dental implants have been practiced by dental practitioner from a long time with a proven track record. However, there are certain key areas for the success of immediate implants and one such critical area is jumping distance which is the space between the implants and the wall of the socket that is filled by various graft materials for ensuring success of dental implants. This review compares dentin graft with different grafts available such as autograft, allograft, and xenograft.

Introduction:

In the past, dental implants could not be inserted until the affected areas had healed for at least four to six months after a compromised tooth was extracted. However, the alveolar ridge changes noticeably at the edentulous location after tooth removal.

The bone resorbs in width as well as height after extraction of natural teeth and it is fastest in first three months of healing. Schorpp et al (2003)¹ in their research concluded that bone resorbs significantly in the first three months post-extraction, whereas the change in morphology continues even after 12 months of removal of a tooth. In recent times, due to increased patient

demand and availability of improved implant surfaces, the research is more aligned towards placement of implants immediately after removal of teeth.^{2,3,4}

In cases where implant is placed immediately, the size of the horizontal defect between the implant surface and the socket wall is a critical component to be considered for the success of the implant. This distance is known as Jumping Distance or Horizontal Defect Distance (HDD) and often needs to be filled with graft material to achieve an optimal outcome. Unless the augmentation procedure is performed, placement of implants in such sites will lead to poor aesthetics result and may also lead to failures. Several graft materials may be used to fill the horizontal defect distance which include bone autograft, DFDA, xenograft, alloplastics such as HA and beta-TCP, bone morphogenetic proteins, hard tissue replacement polymer, autogenous demineralized dentine graft, bioactive materials like (rhBMP-2), PRF and GBR.

For many years, grafts harvested from own body are considered the ideal standard in bone augmentation procedures. However, they are associated with certain limitations such as injury of the donor site, uneven resorption, restricted quantity available, and the need to include secondary sites which have led researchers to search for suitable alternatives. Autogenous tooth-derived (APDDG) graft, has been in clinical use for less time when compared with different augmentation materials, grafts, or substitutes. Bone and dentine are quite similar in their structure and chemical composition. Dentine is primarily composed of organic material consisting of type 1 collagen fibers responsible for calcification⁸. The network of dentinal tubules in calcified dentin helps in the diffusion of nutrients following grafting, this fact was confirmed in a scanning electron microscopic (SEM) study of calcified dentin⁹. Several authors in recent studies have proposed and demonstrated that grafting with dentine as a bone substitute is successful when used to fill the defects in the alveolar ridge, which indicates promising

potential for bone regeneration^{5,6,7,10}. Similarly, the usefulness of dentine graft as a bone augmentation material has already been proven in various clinical situations such as the regeneration of alveolar bone for implant placement associated with direct sinus lift procedures, and extraction sockets preservation^{5,6,7,11,12}. The criteria required for a bone augmentation material i.e. osteoconduction and osteoinduction are completely fulfilled by dentine graft in the aforementioned studies¹³. However, published human data, concerning the therapeutic efficiency of dentine graft for grafting with immediate implants, is scarce.

Moreover, there are no clinical studies with long-term follow-up in current literature evaluating the clinical use of dentine graft in the context of osseointegration with immediate implants in achieving good quality of bone when compared with the already established graft materials (allograft and xenograft) after immediate implant placement in fresh extraction sockets.

Review of literature:

Canto Diaz et al (2019)¹⁹ did a pilot study for evaluating the importance of dentine graft after the extraction of teeth in the sockets. Nine patients who needed to have two single-rooted teeth extracted but were found acceptable for deferring rehabilitation with Osseointegrated implants underwent split-mouth research. The post-extraction socket was left as such for the control group, while the extraction socket was restored with dentine graft for the test group. In both groups, alveoli were analyzed dimensionally and densitometrically at baseline, 8 weeks, and 16 weeks. They concluded that preservation of extraction sockets can be accomplished by using autologous dentin graft material.

Minamizato et al (2018)²⁰ conducted a study to look at the effectiveness and safety of locally prepared dentin matrix. In this study, APDDM transplantation was used to insert dental implants

in 16 individuals. This research outlines the use of tooth graft prepared right away after extraction for augmenting bone, utilizing partial demineralization's quick preparation time.

The aim of Kim's (2015)²¹ study was to assess the clinical value of an autogenous tooth graft made on the operating table for augmentation of the alveolar bone with implants. Patients who required removal of teeth as well as an increase in height and width for dental implant insertion. The graft is prepared from teeth in the clinic to act as augmenting material within two hours. The prepared graft was employed to restore deficiencies concurrently with implantation in the same session. The results were assessed twelve months after the creation and implantation of the prosthesis. For particular cases, random histological examinations were carried out. 12 months after prosthetic rehabilitation, no implants were lost. A histological investigation revealed that the graft material had caused new bone development.

In a clinical setting, Binderman et al. (2014)²² described a novel technique that uses freshly removed teeth inserted into extraction sites. The procedure involves removing any debris, caries, or restorations. A specially created "Smart Dentin Grinder" is used to immediately grind the clean, dry tooth, which consists primarily of dentin. A unique sorting system is used to sieve the 300–1200 µm dentin particulate. The sorted particulate dentin is submerged in a sterile container of a basic alcohol cleanser to kill any bacteria and organic matter. The particulate is then cleaned with sterile saline.

The particulate dentin is devoid of microorganisms and is prepared for rapid transplantation into extraction sites or into areas where there are bone defects. Over 100 treatments were carried out over two years, the majority of which were done to preserve alveolar bone. They came to the conclusion that autogenous mineralized dentin particle grafting done right away after extractions

ought to be regarded as the ideal procedure in sinuses, socket preservation, and bone deficiencies.

Joshi CP et al. (2016)²³ conducted a randomized, prospective clinical, radiographic, and histological study using 2 different graft materials i.e., dentin graft and an alloplastic beta-tricalcium phosphate. We chose 15 patients who were having at least three teeth removed. Extractions were done without trauma. One extraction socket had ATG grafting, one had β -TCP grafting and one extraction socket had no grafting at all. CBCT was used to evaluate bone width and height. ATG-grafted sites outperformed the other two, with just a little loss in alveolar crest height and width. A similar result was also seen in the histological investigation, with ATG-grafted sites showing greater new bone growth than β -TCP-grafted sites. Alveolar ridge height and width are more reliably maintained after extraction thanks to ridge preservation. ATG produced better results than β -TCP did.

Vishambaran M et al (2014)²⁴ did a study on immediate implants with various bone graft material. During this trial, 30 implants were inserted into fresh extraction sockets. For groups A and B, respectively, freeze-dried bone allograft Dembone(®) and modified hydroxyapatite G-Bone(®) were used as graft materials.

The bone around the implants was either constant or even increased throughout the year, and no implants were lost. They concluded that single tooth implants with speedy restoration placed in freshly excised sockets would be seen as a desirable option to replace a missing tooth.

Discussion:

Dental implants have become a very common treatment modality for restoring edentulous patients. As a result, increasing bone support is also increasing with the rise in demand for dental

implants. The best graft for augmenting bone is an autogenic bone graft^{25, 26}. However, it is associated with limitations, like every less quantity, injury at the donor site, and also a loss of up to fifty percent of quantity. Different options are being tried in various clinical situations²⁷, but these also have their limitations, like the ability for host disease transfer, increased expenses, and limited osteoinduction capacity. Hence, the present research is focused on finding a substitute for bone augmentation.

Dentine has been a critical research area because of its potential to be employed as a replacement of bone; it is superior to allograft due to its autologous nature, identical proteins, and lack of immunogenic reaction. Due to the larger mineral concentration, it is denser than allograft. In addition, dentine shares two characteristics with autogenous bone: it is both Osseo-compatible and osteoconductive, so acting as a physical substrate for the formation of new bone. In comparison to allograft, the site will heal far more quickly and be prepared for repair in half the time. Due to all the reasons stated above, the dentine graft is considered ideal material for regeneration of osseous tissues^{28,29}.

Teeth graft as an alternative to bone has been investigated in several earlier research. Mineralized dentin matrix has been demonstrated to have great biocompatibility in several trials, however, it is less effective at promoting bone development than materials obtained from bone^{30,31}. Alternatively, many fundamental animal investigations have revealed that the matrix is comparable to the demineralized bone matrix in terms of being both osteoinductive and biocompatible^{32,33}. Gomes et al. were the first to report the use of dentine graft in conjunction with a membrane for GBR on the extraction sockets.^{33,35} However, most of the research utilized a completely DDM. Also, there is limited literature on in-vivo studies evaluating the clinical use

of Dentine graft in achieving good quality bone when compared with the already established graft materials (allograft and xenograft).

Conclusion:

Autogenous bone grafts are considered to be the gold standard when compared with all other types of graft materials, but morbidity of the donor site, limited available quantity, and high resorption rate are some of the limitations. Dentine has a similar structure and composition when compared with the alveolar bone, so dentine graft could be an ideal replacement for the bone autograft and another type of graft by addressing all their limitations. From the limited studies in the literature, we can infer that dentine grafts have been successfully used for socket preservation, so we can assume that they should perform well with immediate implants also. when we are planning for immediate implants the teeth to be extracted is of no use, but if that extracted teeth can be utilized for grafting the vertical and horizontal distance between the socket wall and implant it will be highly beneficial for the patient in terms of the success rate of immediate implants and financially also it will save the patients cost of graft.

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