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Review Article

Dentine grafts in socket preservation: An overview

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ABSTRACT

Statement of problem: During management of carious teeth, root stumps, fractured roots and unsalvageable teeth, extractions become inescapable. Healing post-extraction is characterized by changes that results in bone formation in the socket internally and changes related to width and height of alveolar ridge externally. The maintenance of height and width of alveolar bone or regeneration of alveolar bone is necessary to provide good support to the prosthesis, conservation of adjacent tooth structure and also for superior and satisfactory aesthetic outcome. A broadly documented approach is the preservation of bone walls by use of bone substitute (bone graft) in the extraction socket, where guided-bone regeneration may be required. Different varieties of bone grafts like autogenous bone grafts, allografts, alloplasts and xenograft may be used. Various factors like donor site morbidity, restricted availability and cost are the limitations of various bone substitutes. A new autogenous bone substitute that is being studied is the extract of patient's own extracted tooth without need for a secondary bone harvesting site. Tooth-derived mineralized dentin matrix exhibits composition similar to the bone and is a viable option for alveolar bone augmentation immediately after dental extraction.

Purpose: The aim of this review is to analyze the role and efficacy of dentine grafts in preservation of post-extraction sockets.

Conclusion: Autogenous dentine graft when used in socket preservation procedures showed many benefits for both patients and the clinicians by excluding donor site morbidity, limited availability and associated cost issues with a better quality of newly substituted bone and minimal amount of residual graft. Future controlled trials are suggested to monitor various tissue changes along with histological studies to provide substantial evidence of its regenerative potential.

1. Introduction

During management of carious teeth, root stumps, fractured roots and unsalvageable teeth, extractions become inescapable. Generally, the extraction of teeth initiates a series of healing process involving soft and hard tissues.

Healing post-extraction is characterised by changes that results in bone formation in the socket internally and changes related to width and height of alveolar ridge externally.[1] Alveolar ridge resorption is a slow irretrievable process with an average decrease in width ranging from 2.6 and 4.6 mm and in height ranging from 0.4 and 3.9 mm after extraction.[2,3] Post extraction till first 6 months, the maximum amount of alveolar bone resorption can be seen and this process continues to occur even till 25 years post extraction.[4]

Resorption rate differs in individuals and it even varies in the same individual at different periods of time. If no measures are employed to prevent this process, 40 to 60% of the total alveolar bone volume may be lost during the

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initial 2 to 3 years post extraction and the phenomenon will progress continuously with a rate of 0.25 to 0.5% per year.[5]

The maintenance of height and width of alveolar bone or regeneration of alveolar bone is necessary to provide good support to the prosthesis, conservation of adjacent tooth structure and also for superior and satisfactory aesthetic outcome. Preservation of the remaining alveolar bone is necessary to minimize unwanted post-extraction changes in ridge dimensions and therefore several approaches for its augmentation are proposed.[6] A broadly documented approach is the preservation of bone walls by use of bone substitute (bone graft) in the extraction socket, where guided-bone regeneration may be required.[7,8]

Alveolar socket preservation (ASP) is a technique to preserve the ridge dimensions and bone post extraction for future rehabilitation by placing a graft / substitute in the socket, with or without the use of barrier membranes or soft tissue coverage immediately following extraction.[9] Different varieties of bone grafts like autogenous bone graft, demineralized freeze-dried bone allograft, calcium sulphate, synthetic hydroxyapatite, bioglass and xenograft may be used. Various factors like donor site morbidity, restricted availability and cost are the limitations of various bone substitutes.[10]

Xenograft is a deproteinized, defatted graft of bovine or porcine origin which is available as porous grains of varying sizes (0.25–2 mm) and made free of all its organic components by processing through high-temperature procedures to reduce the antigenic reactions. The xenograft particles have the properties to promote bone fill and are stable grafting material. It is studied that the use of the bovine xenograft significantly embraces the socket in place and the socket sizes reduce only by 8-17%.[11]

A new autogenous bone substitute that is being studied is the extract of patient's own extracted tooth without need for a secondary bone harvesting site. Tooth-derived mineralized dentin matrix exhibits composition similar to the bone and is a viable option for alveolar bone augmentation immediately after dental extraction.[12,13]

Autogenous dentin matrix graft is either mineralized or demineralized. Autogenous mineralized dentine matrix differs from demineralized dentine matrix by the lack of a demineralization process, which is time taking, expensive and less preferred. The dentine grinders around 95% of the patient's extracted tooth into granules of mineralized dentin (250 μm to 1,200 μm particulate size) representing a prospective bone substitute that can be used in Guided Bone Regeneration (GBR) techniques.[14]

Research towards developing autoclavable jars along with dentine processing devices to further minimize the cost of the whole process is under progress. The aim of this review is to analyze the role and efficacy of dentine grafts in preservation of post-extraction sockets.

2. Previous Research Evidence

In 1993, Donovan MG et al[15] stated that "Jaw bones, alveolar bone and teeth develop from cells of the neural crest and many proteins are common to bone, dentin, and cementum. Dentin that comprise of more than 85% of tooth structure can serve as native bone grafting material." In 2002, Qin c et al[16] found that there are similarities in chemical compositions of teeth, dentin in specific and bones.

In 2005, Schmidt-Schultz and Schultz et al[17] brought out the fact that ancient human bone and teeth had collagenous extracellular matrix with in which the growth factors were well-preserved. Bone morphogenic protein (BMP) and type I collagen, responsible for the bone formation and resorption are present in tooth dentine and cementum.

With similar histological background between tooth and bone; due to its osteoconductive, osteoinductive and osteogenic potential that occurs through growth factors present in tooth, a novel bone graft material have been derived from the organic and inorganic contents of the extracted tooth.

3. Technique for Socket Preservation

The method of preparation varies depending on the type of dentine graft i.e Demineralized or mineralized dentine graft. The tooth needing extraction due to various reasons which is nonfunctional non salvageable or impacted can be extracted. The tooth should be vital and root canal treated tooth has to be excluded. Care should be taken to perform minimally invasive atraumatic tooth extraction under LA to prevent damage to the marginal bone.

Later the extracted teeth should be scaled and caries along with enamel and cementum should be removed using a round carbide bur. Pulp extirpation should be done. The tooth should be fragmented and powdered using a dentine processing grinder with motor rating of 1500 Watts at 700 rpm speed for 60 seconds. The particles of diameter 250-1200 microns were obtained and passed through two autoclaved sieves consecutively to acquire graft with desired particle size. For demineralized dentine graft, the particles must be clinically sterilized using a protocol having proven efficacy. The graft particles should be immersed in 1 N lactic acid for 15–20 minutes to partly decalcify the autogenous dentin particles and later should be washed thoroughly using sterile normal saline for 1 minute to eliminate traces of lactic acid. For mineralized dentine graft, apply cleanser to the particulate graft for 5 min. (0.5 M NaOH and 20% (v/v) alcohol), then rinse twice with Phosphate buffered Saline (PBS) and final graft material can be placed in the extraction socket.

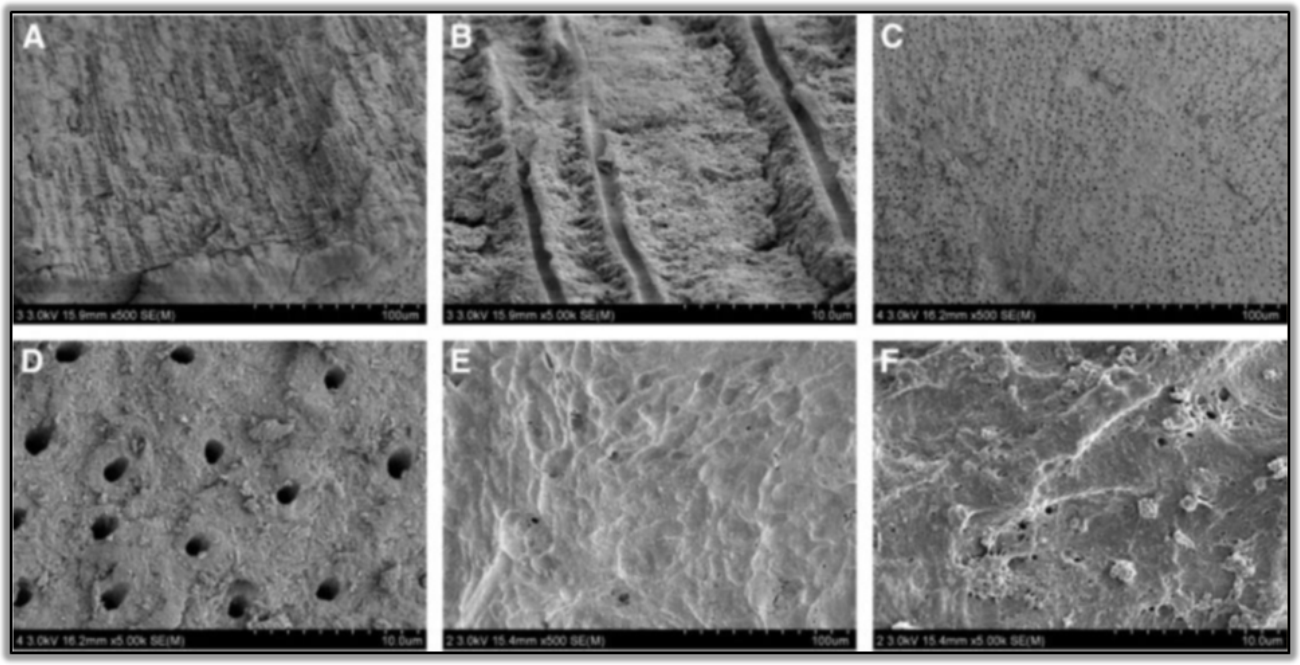

Fig. 1: SEM Views of the Different types of graft Materials. A, tooth Crown (×500); B, tooth Crown (×5000); C, tooth root (×500); D, tooth root (×5000); E,Autogenous cortical bone (×500); F, Autogenous Cortical bone (×5000).[13]

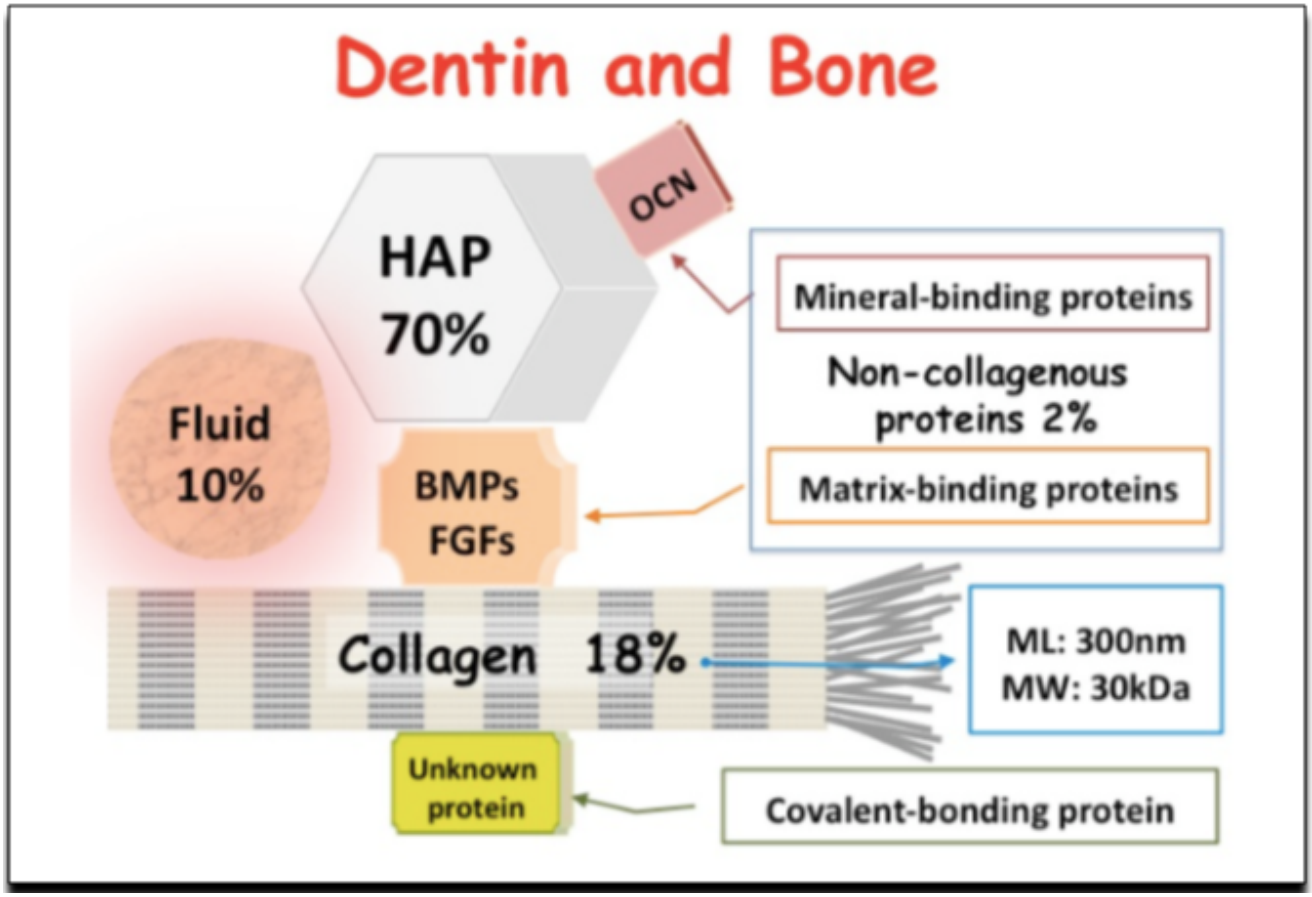

Fig. 2: Composition of dentin and bone[18]

4. Scientific Background

Bone and tooth are hard tissues with comparable features like morphology, microstructure which can be seen in Figure 1 inspite of differences in the developmental period. Enamel, dentin, cementum, pulp and periodontal ligament are the various dental tissues developing from the neural crest cells like the alveolar bone. Bone is built from multiple harversian systems, whereas dentin is a complex of 4 components:-

1. Oriented tubular.
2. A peritubular zone embedded in an intertubular matrix which is highly mineralized.
3. Type I collagen with embedded apatite crystals.
4. Dentinal fluid.

5. Composition

Tooth dentin and cementum contain growth factors like type I collagen and bone morphogenic protein. Dentin graft is composed majorly of protein that may be non-collagenous and collagenous along with lipids, ions, hydroxyapatites.

The non-collagenous proteins and growth factors play a role in bone formation as well as resorption which include phosphophoryn, osteonectin, osteocalcin, sialoprotein, proteoglycan, glycoprotein, bone morphogenic proteins (BMPs), lactate, biopolymer, lipid, citrate. The non-collagenous proteins in dentin and bone are secreted into the extra cellular matrix in the process of bio mineralization. This SIBLING (Small Integrin-Binding Ligand, N-linked Glycoprotein) family included dentin sialophosphoprotein (DSPP), dentin matrix protein 1 (DMP1), bone sialoprotein (BSP) and osteopontin (OPN). In 1990, Finkelman et al established that Demineralized Dentin Matrix (DDM) and Demineralized Bone Matrix(DBM) contain type I collagen and few growth factor and defined them as acid-insoluble collagen binding BMPs, member of transforming growth factor-beta (TGF-β) super-family. Kim et al in 2011[19] observed that human bone tissues and tooth consists mineral content of low crystalline hydroxyapatite and other calcium phosphate minerals like octacalcium phosphate, amorphous calcium phosphate and β-TCP.

5.1. Advantages

1. Biocompatible.
2. No secondary donor site.
3. Donor site preparation is simple.
4. Autogenous and so osteoinductive.
5. Rich in HA and so osteoconductive.
6. Osteogenic.
7. No immunological host response.
8. Cost effective.
9. Chair side preparation.
10. Less time taken for preparation.

5.2. Limitations

1. Requires physiologically nonfunctional tooth.
2. Root canal treated tooth.
3. Preparation is technique sensitive.
4. Special armamentarium required.

6. Conclusion

Autogenous dentine graft when used in socket preservation procedures showed many benefits for both patients and the clinicians by excluding donor site morbidity, limited availability and associated cost issues. The novelty of dentine grafts is that due to osteoconductive, osteoinductive and osteogenic potential they have been proven to show a better quality of newly substituted bone and minimal amount of residual graft when used in socket preservation procedures.

Though, patient selection and treatment planning play an important role in achieving a predictable outcome; future controlled trials are suggested to monitor various tissue changes along with histological studies to provide substantial evidence of its regenerative potential in other fields as well.

7. Source of Funding

None.

8. Conflict of Interest

None.

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