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Use of autologous dentin matrix in bone defects augmentation — a literature review

Ewa Wysłouch, Artur Sipika, Natalia Grabowska-Jasik, Michał Tyrakowski, Tomasz Kaczmarzyk, Mariusz Szuta

Oral Surgery Department, Dental Institute, Jagiellonian University Medical College, Kraków, Poland

Corresponding author: Ewa Wysłouch, D.D.S.
Oral Surgery Department, Dental Institute, Jagiellonian University Medical College
ul. Montelupich 4, 31-155 Kraków, Poland
Phone: +48 12 424 54 68; E-mail: e.wyslouch@doctoral.uj.edu.pl

Abstract: A number of regenerative materials are currently used to regenerate or preserve the alveolar process. One of these is autogenous dentin matrix. With many valuable properties such as easy availability, simple preparation, low cost, low risk of disease transmission and no risk of triggering an immune response against the graft, autogenous dentin matrix appears to be a very good material of choice. The following article is intended to provide an overview of the use of autogenous dentin matrix.

Keywords: autologous dentin matrix, tooth-derived matrix, dentin graft, biomaterials, tooth graft, demineralized dentin matrix, PRF, sticky tooth.

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For proper restorative procedures of missing teeth with implants, the presence of adequate alveolar dimensions is essential. When a tooth is lost, the lack of stimulation of the remaining bone results in a decrease in its dentsity, as well as a loss of width and height of the alveolar process. This is particularly noticeable in the first 8 weeks after tooth extraction. Bone height gradually decreases by 25% during the first year after tooth loss, with an average of 4 mm of bone loss in height during the first year after extraction. These changes can make it difficult to place the implant in the correct three-dimensional position. For implant treatment planning, depending on the clinical situation, there are procedures implemented immediately after tooth extraction: socket preservation (SP), ridge preservation (RP) or for late implantation: guided bone regeneration (GBR): including sinus lift procedures.

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Bone defects also occur as a result of other surgical procedures-e.g., enucleation of dentigerous cyst. As cyst increases in size, it leads to resorption of the surrounding bone tissue from compression. Removal of the cyst leads to formation of a bone defect with the ability to regenerate spontaneously; however, healing is subject to the risk of incomplete osteogenesis with processes of reparation with connective tissue instead of bone, pathologic bone fractures, and reduction of the height of the alveolar process of the maxilla or the alveolar part of the mandible.

Performing guided bone regeneration can reduce the risk of the above complications.

Autogenous, allogeneic, xenogeneic and alloplastic materials are used for these purposes.

Regenerative materials are used to restore the normal function and volume of damaged tissues. They work by one of three mechanisms: osteogenesis, osteoinduction or osteoconduction.

Osteogenesis is the ability of the material to produce new bone tissue — this is a unique feature of autogenous materials, i.e. own bone that contains living osteoblasts.

Osteoinduction is the ability of a material to stimulate surrounding tissues to produce bone tissue. It is a property of autogenous and allogeneic materials (derived from individuals of the same species).

Osteoconduction is the ability of a material to grow bone tissue, or more precisely, to become a kind of scaffold for the newly formed bone. Such properties are possessed by autogenic, allogeneic, xenogeneic (obtained from individuals of other species) and alloplastic (natural or synthetic foreign bodies) materials.

Since autogenous materials work by all three of these mechanisms, they are still considered the gold standard in the regeneration of alveolar bone defects.

The use of autogenous materials is often associated with the risk of donor site complications, particularly if the donor site is outside the oral cavity (e.g., the iliac plate, fibula, cranial bone vault) and the inability to collect the material in a dental office setting [1].

To overcome these disadvantages, an alternative bone substitute to autogenous bone has been sought. One of them is autogenous augmentation material extracted from the patient's own teeth. This type of material is not new. As early as 1967, Urist conducted research on the osteogenic properties of demineralized material extracted from teeth — autogenous demineralized dentin matrix. Subsequently, numerous researchers began attempts to use teeth as graft material for bone formation, due to the existing similarities between the structure of tooth and bone, i.e. their common origin in the neural tube and the fact that the chemical composition of bone is very similar to teeth, especially dentin [2].

The use of dentin autografts in humans was first reported in 2003 for sinus lift procedure [3]. It has been proven that autologous dentin matrix has osteoinductive and osteoconductive properties thanks to its chemical composition and biological content [4]. The composition of dentin is quite similar to bone tissues considering the content of hydroxyapatite (60–80%), type I collagen, and growth factors such as: insulin-like growth factor (IGF)-II, bone morphogenetic protein (BMP)-2, or transforming growth factor (TGF)-b. Most of the proteins contained in the dentine are also present in bone [5]. The density of bone formation around autologous dentin matrix granules after augmentation of bone defects is higher compared to control groups that are free of autologous dentin matrix granules [6]. There are three types of dentin materials: mineralised dentin matrix, partially demineralised dentin matrix and demineralised dentin matrix. As the degree of demineralization increases, the osteoinductive properties improve [7].

There are several systems available on the market for preparing and processing dental material. The authors have the most experience using The Smart Dentin Grinder system from KometaBio.

The other devices that may be used to prepare dentin graft are Tooth Transformer and BonMaker that are more automated than KometaBio Dentin Grinder [8]. The process of obtaining dentin matrix using KometaBio The Smart Dentin Grinder is as follows. According to Bindermann *et al.* and official manufacturer's protocol, after extraction, using a high-speed handpiece all decay, artificial material like dental fillings or crowns and debris from patient's extracted teeth are removed, so that only the clean tooth remains. Then the tooth is dried by air syringe. Next using a sterile disposable grinder we obtain dentin particles of 300–1200 micron. The grinding process can be repeated depending on the amount of tooth remnant. The particulated dentin is placed in a sterile, closed dish containing a solution of sodium hydroxide (0.5 N, 4 mL) and ethanol (20 vol.%, 1 mL) (Dentin Cleanser) for 5 minutes to dissolve all organic remnants and bacteria. Following the exposure time, the excess is removed with sterile gauze and the compound is washed for less than 1 min in phosphate-buffered physiological saline (PBS), then is dehydrated using sterile gauze and again washed in PBS. The optional addition of EDTA after Dentin Cleanser will result in 20 microns of demineralized dentin surface exposure to induce osteogenic activity of dentin. To obtain tooth-derived factors it is necessary to demineralize the dentin to open the dentinal tubules and expose the BMPs [8]. The BMP guides modulation and differentiation of mesenchymal cells into bone and bone marrow cells [9]. After completing all the steps the material is ready for grafting [10, 11]. The obtained material volume is more than twice of the original tooth volume [12].

One of the advantages of autologous dentin matrix is the ability to process the teeth immediately after their removal into bone replacement material. Teeth that were before considered as clinical waste, now can be effective graft for augmentation procedures. Teeth used in the procedure are usually extracted due to periodontal bone loss, orthodontic indications, deciduous teeth, the impacted teeth in most cases the wisdom ones. Teeth after root canal treatment shouldn't be used because of the risk of contamination by foreign materials. Harvested tooth can be mechanically and chemically treated providing a particulate material within few minutes [13]. Presented technique allows to obtain material that is fully autogenous and the possibility of adverse immune reactions is reduced to minimum in opposite to biomaterials of animal origin. The use of own tooth that has to be extracted for surgical or orthodontic indications is free of any biological or economic cost. By adding platelet rich fibrin (PRF) to autologous dentin matrix granules is possible to obtain material called "sticky tooth". PRF accelerate healing thanks to high amounts of blood derivatives such as transforming growth factor Beta-1 (TGF beta-1), platelet derived growth factor AB (PDGF-AB) or vascular endothelial growth factor (VEGF), while the dentin provides the scaffold or new bone formation [14–16]. The addition of PRF is also beneficial due to its antibacterial properties [17]. It includes local angiogenesis, entraps circulating stem cells, modulates the immune system of the wound site, and enhances the mitogenesis of epithelial cells [18]. In addition, PRF increases the volume of the graft material, allowing regeneration of larger areas. Autologous dentin matrix or combination of autologous dentin matrix with PRF may be used in vary clinical situations like alveolar ridge preservation or bone defects augmentation.

However, the question of microbiological purity of the material obtained should be viewed critically. In the study presented by Wojtowicz *et al.* the sterility of the samples was achieved in only 5% of the samples, with no relation to whether the processed teeth were initially free of contamination (e.g., completely impacted teeth) or whether they were complicated by a carious process or periodontal disease. It is worth noting, that in the cited studies no quantitative analysis was performed, only qualitative analysis of the samples [19]. There are no publications in the available literature indicating an increased risk of inflammatory complications after autologous dentin matrix application. It should be noted, that the results of similar studies evaluating the microbiological purity of autogenous bone harvested intra-orally clearly indicate the inability to achieve graft sterility, which should prompt clinicians to consider the validity of using these procedures in immunocompetent patients and to consider antibiotic prophylaxis.

The use of autogenous dentin matrix in regenerative procedures in oral surgery is not a novel method, and numerous cited publications attest to its effectiveness. The relative ease of obtaining graft material makes this method competitive among others, including autogenous bone augmentation considered the gold standard, and the osteoinductive properties give it an advantage over widely used xenogeneic materials.

The unavailability of autogenous dentin matrix in Polish tissue banks forces clinicians to prepare the augmentation ex tempore after tooth extraction, which can prolong the duration of the surgical procedure. It seems that the controversial issue of microbiological purity of the extracted material requires further clinical studies, including using quantitative analysis.

References

1. *Dominiak M., Zapała J., Gedrange T.*: Podstawy Chirurgii Stomatologicznej. Edra Urban & Partner 2016; pp. 247–257.
2. *Pang K.-M., Um I.-W., Kim Y.-K., Woo J.-M., Kim S.-M., Lee J.-H.*: Autogenous demineralized dentin matrix from extracted tooth for the augmentation of alveolar bone defect: a prospective randomized clinical trial in comparison with anorganic bovine bone. Clin Oral Implant Res. 2017; 28: 809–815.
3. *Murata M.*: Autogenous demineralized dentin matrix for maxillary sinus augmentation in humans: The first clinical report [abstract]. First International Association for Dental Research (IADR/ PER General Session), 25–28 Jun 2003, Göteborg, Sweden. International Association for Dental Research.
4. *Cardaropoli D., Nevins M., Schupbach P.*: New Bone Formation Using an Extracted Tooth as a Biomaterial: A Case Report with Histologic Evidence. Int J Periodontics Restor Dent. 2019; 39: 157–163.
5. *Kim Y.K., Kim S.G., Byeon J.H., et al.*: Development of a novel bone grafting material using autogenous teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010; 109: 496–503.
6. *Inchingolo A.M., Patano A., Di Pede C., Inchingolo A.D., Palmieri G., de Ruvo E., et al.*: Autologous Tooth Graft: Innovative Biomaterial for Bone Regeneration. Tooth Transformer® and the Role of Microbiota in Regenerative Dentistry. A Systematic Review. J Funct Biomater. 2023 Feb 27; 14 (3): 132.
7. *Bernardi S., Macchiarelli G., Bianchi S.*: Autologous Materials in Regenerative Dentistry: Harvested Bone, Platelet Concentrates and Dentin Derivates. Molecules. 2020 Nov 15; 25 (22): 5330. doi: 10.3390/molecules25225330.
8. *Gandolfi M.G., Taddei P., Pondrelli A., Zamparini F., Prati C., Spagnuolo G.*: Demineralization, collagen modification and remineralization degree of human dentin after EDTA and citric acid treatments. Materials (Basel). 2018; 12: 25. doi: 10.3390/ma12010025.
9. *Urist M.R., Strates B.S.*: The Classic: Bone morphogenetic protein. Clin Orthop Relat Res. 2009 Dec; 467 (12): 3051–3062.
10. Autologous Dentin Grafting Protocol — The Smart Dentin Grinder® by Kometa Bio, available online https://www.kometabio.com/_files/ugd/db0fd7_45cdd81b9a6647a599cdebd01ae3c720.pdf.
11. Procedure for preparing partial demineralized dentin graft — by Kometa Bio, available online https://www.kometabio.com/_files/ugd/944b9c_48b2a23e70ae4c698e36a4ea769540a1.pdf.
12. *Souza J.C.M.; Escobar M., Pimentel I.S., Caramês J., Teughels W., Silva F., Henriques B.*: Tooth-Derived Matrix Granules for Enhanced Bone Healing: Chemical Composition, Morphological Aspects, and Clinical Outcomes. Ceramics. 2022; 5: 981–990.

13. *Binderman I., Hallel G., Nardy C., Yaffe A., Sapoznikov L.*: Processing extracted teeth for immediate grafting of autogenous dentin. Implant Practice US. 2014; 8: 43–46.
14. *van Orten A., Goetz W., Bilhan H.*: Tooth-Derived Granules in Combination with Platelet-Rich Fibrin ("Sticky Tooth") in Socket Preservation: A Histological Evaluation. Dent J. 2022; 10: 29.
15. *Pohl S., Binderman I., Tomac J.*: Maintenance of Alveolar Ridge Dimensions Utilizing an Extracted Tooth Dentin Particulate Autograft and Platelet-Rich Fibrin: A Retrospective Radiographic Cone-Beam Computed Tomography Study. Materials (Basel). 2020 Mar; 13 (5): 1083.
16. *Andrade C., Camino J., Nally M., et al.*: Combining autologous particulate dentin, L-PRF, and fibrinogen to create a matrix for predictable ridge preservation: a pilot clinical study. Clin Oral Invest. 2020; 24: 1151–1160.
17. *Drago L., Bortolin M., Vassena C., Taschieri S., Del Fabro M.*: Antimicrobial activity of pure platelet-rich plasma against microorganisms isolated from oral cavity. BMC Microbiol. 2013; 13: 47–47.
18. *Choukroun J., Diss A., Simonpieri A., Girard M.-O., Schoeffler C., Dohan S.L., et al.*: Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part IV: clinical effects on tissue healing. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Mar; 101 (3): e56–60. doi: 10.1016/j.tripleo.2005.07.011.
19. *Wojtowicz A., Wychowański P., Osiak M., Kresa I.*: Analiza mikrobiologiczna tkanek zębów w procedurze mielenia, procesowania i autotransplantacji GBR. Dental Tribune Poland, 03.01.2018.