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The International Conference on Business, Technology, and Innovation (IC-BTI 2025) is the 14th international interdisciplinary peer-reviewed conference which publishes the works of scientists as well as practitioners in the areas where UBT is active in education, research, and development. The UBT aims to implement an integrated strategy to establish itself as an internationally competitive, research-intensive institution, committed to the transfer of knowledge and the provision of a world-class education to the most talented students from all backgrounds. It is delivering diverse academic programs across science, management, and technology, fostering innovation and excellence in research. This year we proudly celebrate our 24th Anniversary as an institution dedicated to advancing science, education, and global collaboration. The main perspective of the conference is to connect scientists and practitioners from different disciplines in one place, make them aware of the recent advancements across research fields, and provide them with a unique forum to share their experiences. It is also an important platform to support new academic staff in conducting research and publishing their work at international standards.

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We would like to express our sincere gratitude to all authors, partners, sponsors, reviewers, and the conference organizing team for making this year's event a truly international scientific gathering. In 2025, we have seen increased participation, submissions, and publications, demonstrating the growing relevance and impact of IC-UBT.

Congratulations! Edmond Hajrizi,
Rector of UBT and Chair of IC - BTI 2025

CONTENTS

Usage of biomaterials in contemporary periodontology

Lumturije Asllani Hashani[1], Ana Minovska [2], Mihajlo Petrovski [3], Merita Barani[4]
Doruntina Shehu [5]

1 Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia
lumturie.31175@student.ugd.edu.mk
2 EternaDent, Skopje, North Macedonia
3 Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia
4 Faculty of dentistry of UBT, Prishtine, Kosova
5 Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia
merita.barani@ubt-uni.net, mihajlo.petrovski@ugd.edu.mk,
aminovska@yahoo.com,doruntina.311108@student.ugd.edu.mk

Abstract. The main aim of this article was to make a literature review about biomaterial-based bone replacement grafts, and membrane alternatives that can have periodontal applications. A variety of clinical methods and materials have been investigated over last decades for reparation and regeneration of periodontal defects. The available therapeutic options and their clinical outcomes have improved significantly due to the invention of advanced biomaterials for periodontal tissue engineering. Among the effective grafting materials are allografts, and their use has shown a substantial degree of bone growth and proliferation, making them a wise choice for the restoration of missing bone, caused by periodontal inflammatory process. Polymers, both natural and synthetic, are more commonly used as barrier materials in guided tissue regeneration (GTR) and guided bone regeneration (GBR) applications. In conclusion, we can note that through using modern biomaterials in periodontology, the success of therapeutic procedures is significantly greater than in the past.
Keywords: biomaterials, allografts, periodontology, periodontal treatment

Introduction

The chronic, untreated loss of periodontal tissues gingiva, alveolar bone, periodontal ligament, and cementum leads to tooth loss, which has consequences for both function and appearance. In an effort to replace or regenerate periodontal tissues that have been lost or destroyed as a result of illness, numerous treatment approaches (both surgical and non-surgical) have been researched. Soft and hard tissue replacement grafts, guided tissue/bone regeneration (GTR/GBR), root surface biomodification, and growth factor delivery have all been created in an effort to promote periodontal regeneration (38). For periodontal regenerative applications, four main hard tissue replacement graft materials are frequently used. These include allografts, xenografts, autografts, and alloplasts. Autografts, which are graft materials taken from the same person, have long been regarded as the "gold standard" (34). However, the volume of bone received is typically restricted, there are worries regarding donor site morbidity (48), and the replacement rate of those autografts may be unexpected (25). Allografts come from donors of the same species and can take the form of fresh/frozen, freeze-dried, or demineralized bone (19). Because they contain proteins like bone morphogenetic proteins (BMP), these allografts have the potential to operate as both osteoconductive scaffolds and osteoinductive materials (39). Xenografts, which come from a different species, are frequently employed in clinical applications for periodontal regeneration therapy. Ceramics and polymers are examples of alloplastic materials, which can be either natural or artificial. With the usage of allografts and xenografts, there may be a danger of disease transmission or cross infection (26). Different barrier membranes have been designed and studied to stop the epithelial cells from shrinking along the tooth-root surface and into the periodontal defect region (50). These membranes can be produced utilizing natural or synthetic materials, just like the hard tissue replacement graft materials (51).

Indications for bone augmentation

Applications of bone augmentation procedures include sinus augmentation, horizontal ridge augmentation, vertical ridge augmentation, and extraction socket defect grafting. A variety of methods are used to optimize the outcomes for each of these applications. They can be used separately or in combination, and they include distraction osteogenesis, membrane usage, block grafting, and particle grafting (7).

The ultimate objective of therapy is to offer a functional restoration that is in harmony with the surrounding natural dentition when evaluating the various treatment techniques for the prosthetic replacement of teeth after tooth loss. A common aftereffect of tooth loss is the resorption of alveolar bone, which poses a clinical issue, particularly in the aesthetic zone. This can jeopardize the treatment's structural and functional characteristics. In order to reach this therapeutic goal, it is preferable to offer care that will work to preserve the natural tissue shapes in order to make room for the suggested implant prosthesis. However, it is frequently necessary to augment and regenerate the missing bone. More focus is being placed on oral health due to the growing use of dental implants to restore both partial and complete edentulism.

To simplify communication among clinicians in the choice and sequencing of reconstructive surgeries intended to remove these anomalies, a classification for alveolar ridge deficiencies has been proposed. (41).

- A class I defect has normal ridge height in an apico-coronal direction and bucco-lingual tissue loss.
- A class II defect has normal ridge width in a bucco-lingual direction and apico-coronal tissue loss.
- A class III defects lose height and width due to a combination of bucco-lingual and apico-coronal tissue loss

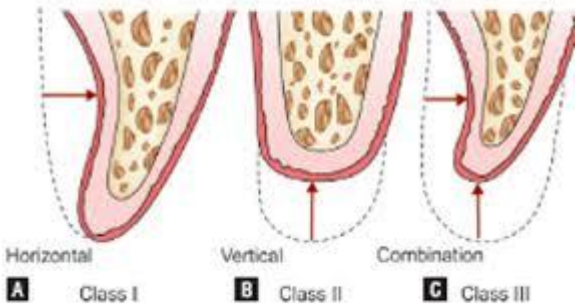

Fig. 1. A classification for alveolar ridge defects

Relative contraindication

- Inadequate self-performed oral hygiene
- Many sites of bony and tissue defects
- Unable to achieve wound closure after surgery due to insufficient soft tissues
- Smokers over two packs of cigarettes, which damages the peripheral circulation and
- compromises the peripheral circulation which affects bone regeneration
  systemic diseases that can interfere in those procedure (5)

Autografts

Autografts are taken from the same person's donor site and placed in a different location. The most osteogenic organic material for grafting comes from autografts, however there are drawbacks, including donor site morbidity and a finite amount of graft volume that may be acquired (48, 31). Both extraoral and intraoral autografts may be employed in periodontal regeneration. The spina nasalis, the tuberosity, and the crista zygomatico-alveolaris from the maxilla, the ramus, the retromolar region, and the symphysis region in the jaw, as well as bony exostoses and bone collected from various places using bone scrapers, are the intraoral autograft harvest sites (17). Common uses for mandibular autografts include bone chips, blocks, and milled particles (33, 42). Autografts taken from extraoral locations, including the iliac crest, have the potential to be both osteoinductive and osteogenic (14). Another extraoral location where bone tissue for surgical purposes may be obtained is the calvaria (43, 24).

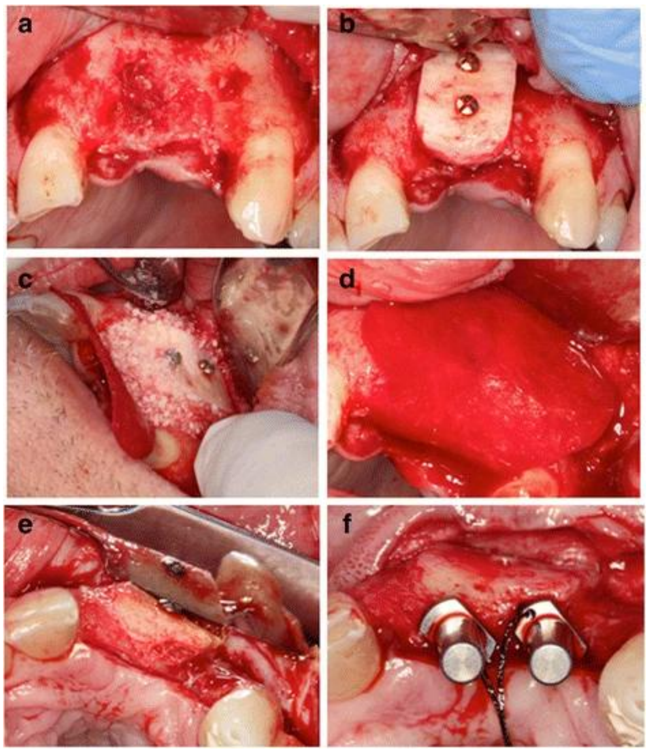

Fig. 2. Clinical photographs showing autogenous block grafting. a Advanced vertical and horizontal bone loss. b Autogenous block graft fixed with screws. c FDBA particles added to fill any remaining gaps. d Porcine degrdable collagen membrane (Bio-Gide) used to contain and cover bone grafts. e. Six month results showing successful bone augmentation. f Dental implants successfully placed into augmented bone. (Courtesy of Dr. Aditya Patel, periodontist, Halifax, NS, Canada)

Allografts

Allografts are tissues acquired from genetically different humans or other members of the same species. They lack the customary drawbacks of autografts and are readily available in large quantities for application. Due to screening and virucidal tissue processing techniques, cancellous and cortical allografts of varied particle sizes are frequently used for bone regeneration treatments with little danger of disease transmission (6, 4). However, there is a potential that new, undiscovered infections could contaminate tissues and spread disease, these pathogens might not be stopped by the current techniques for donor screening and tissue processing. Despite the fact that no cases of prion disease from bone allografts have been reported to our knowledge, the concern is real (2). Additional elements including human error, persistent antibody-negative carriers, and immunovariant strains should be taken into account (10, 18).

As cortical wedges, cortical chips, cortical granules, and cancellous powders produced as frozen, freeze-dried, mineralized, and demineralized bone, allografts are accessible for periodontal applications (3).

Xenografts

Animal tissue is used in xenografts, which are often osteoconductive and have a limited capacity for resorption (45, 30). The deproteinized bovine bone mineral, also known as Bio-Oss®, is the xenograft that is most frequently utilized in periodontal regeneration treatments. It is a commercially accessible bone of bovine origin that has undergone processing to give natural bone mineral free of organic components (29). The primary component of the inorganic phase of bovine bone after heat and chemical treatments is hydroxyapatite (HA), which preserves the porosity architecture (23). Although heat and chemical processing remove the majority of the osteogenic components from bone, it still leaves a small chance for transplant rejection and the transmission of diseases such bovine spongiform encephalopathy (44, 46). Alveolar ridge augmentation treatments and intra-bony defect filling have both been performed using bovine-derived bone graft blocks and particles (49, 47).

In addition to bone mineral derived from cattle, bone mineral can also be acquired from equine or porcine sources. The porous anorganic bone graft material porcine bone graft tissue is primarily composed of calcium phosphate (35, 37).

Alloplasts

To address the drawbacks of autografts, alloplastic synthetic biomaterials were created. They come in a variety of shapes, have a range of physicochemical characteristics, and can either be biodegradable or not (52, 54, 55). Alloplasts have been employed extensively for periodontal regeneration since they are often osteoconductive and lack any osteoinductive or osteogenic capacity on their own (57). The three most frequently employed alloplastic substances are bioactive glasses, tricalcium phosphates (TCP), and HA. Since they have a composition similar to bone mineral, are osteoconductive, form bone apatite-like material or carbonated HA, and form a very strong bone-calcium phosphate biomaterial interface, calcium phosphate biomaterials are of great interest for use as bone replacement graft materials in periodontal regeneration (52, 53).

Barrier membranes for periodontal guided regeneration applications

The theory behind membrane-based periodontal regeneration is the surgical insertion of physical barriers to separate various tissues (28). Since the rate of regeneration of soft tissues is higher than that of bone and periodontal tissue, barrier membranes allow for the preservation of defect space for regenerating tissues, which would otherwise be invaded and occupied by epithelial cells. The membranes also serve to support, confine, and protect the graft components when utilized in conjunction with bone grafts (51). Additionally, this slows the pace of graft resorption (11, 56). For periodontal GTR and GBR applications, numerous degradable and non-degradable barrier membranes have been created (50, 51). Designing barrier membranes for periodontal regeneration requires taking into account a number of factors, including 1) biocompatibility, 2) cell-occlusivity, 3) space-making capability, 4) tissue integration, 5) degradability, 6) mechanical qualities, and 7) clinical handling features (21, 15).

Other strategies for periodontal regeneration

Periodontal regeneration is being pursued through ongoing research into better techniques and technologies. It is being researched to provide altered genetic material to periodontal cells (gene therapy) to enhance their capacity for regeneration by raising the concentration and synthesis of differentiation factors and growth factors (27, 8). In vitro amplification of osteoblasts or osteoprogenitor cells grown on 3D structures has been examined as a cellular tissue engineering technique to boost bone's regeneration capability (22, 20). Mesenchymal stem cell cell seeding of constructs has significant promise for usage in the future (16, 9). The use of matrix derivatives (EMD), bone morphogenetic proteins (BMPs), platelet rich plasma (PRP), and investigating mineralization techniques for in situ attachment of periodontal membranes have also generated a lot of attention.

The future of periodontal regeneration

According to a recent consensus report from the American Academy of Periodontology Regeneration Workshop, the use of lasers, scaffolds, bone anabolics, genetic therapy, protein and peptide therapy, and cell-based and cell-based therapies are some of the emerging technologies for periodontal regeneration that are increasing the possibility of reconstructing the entire periodontal organ system. However, the evidence for newly developed periodontal regenerative technologies is yet insufficient to support firm clinical recommendations (13). Additionally, numerous studies have shown that organic or inorganic scaffolds and adult stem cells interact well in vitro. So, the capacity for bone regeneration in in vivo grafts has been successfully and greatly increased using tissue engineering techniques. Future research could lead to the creation of specialized 3D composite scaffolds grafted with stem cells that are carefully crafted to match the precise geometry of the bone defect and enable full restoration of deficiencies in both hard and soft tissues (12).

Conclusion

Bone loss after tooth extraction is a common physiological occurrence. When teeth are extracted and not replaced by implants or prosthetics, there is a significant amount of bone loss. Alveolar ridge resorption occurs both vertically and horizontally over time, eventually leaving insufficient bone for implants. Bone augmentation is required as a result.

With the use of various materials, including autografts, allografts, alloplasts, and xenografts, bone-deficient areas can be augmented through the process of bone grafting. Applications of bone augmentation techniques include sinus lifting, horizontal ridge augmentation, vertical ridge augmentation, and extraction socket defect grafting.

They can be used separately or in combination, and they include distraction osteogenesis, membrane usage, block grafting, and particle grafting.

Smokers, poor dental hygiene done by the patient, numerous areas of bony and tissue abnormalities, and difficulty achieving wound closure following surgery due to insufficient soft tissues are relative contraindications for bone augmentation. These include, but are not limited to, distraction osteogenesis, ridge splitting, the use of barrier membranes for GBR, particle grafting materials, onlay block grafting techniques, distraction osteogenesis, and a combination phased approach of these treatments for severe defects.

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