

Updating on autogenous bone graft material in dentistry

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Abstract

Background: Prosthodontic therapy, such as dentures and implants, can be options for rehabilitating the oral cavity for patients who have lost teeth. However, defects in the alveolar bone pose a challenge in prosthodontic treatment. Among the various bone grafting materials available, only autogenous bone offers osteogenic, osteoinductive, and osteoconductive characteristics compared to other bone substitute and composite materials. Due to its properties and lack of immunological reaction, autogenous bone grafts are widely regarded as the gold standard and the most efficient material for bone regeneration procedures.

Objectives: To review and assess the efficacy, advantages, disadvantages, and clinical outcomes of autogenous bone graft materials in dentistry.

Conclusion: Autogenous bone graft material remains a gold standard in dentistry for its excellent biological properties and high success rates. Autogenous bone grafts involve using a patient's own bone, typically harvested from intraoral or extraoral sites, to regenerate bone in dental implant placement, ridge augmentation, and other reconstructive procedures. Moreover, autogenous bone grafts demonstrate excellent biocompatibility, as they come from the patient's own body. The use of autogenous bone grafts also eliminates concerns regarding disease transmission, making it a safe and reliable option.

Keywords: Autogenous; Bone Graft; Bone Substitutes; Bone Augmentation

1. Introduction

In this modern era, the goal of dentistry is to restore function, aesthetics, comfort, speech ability, and patient health. Prosthodontic therapy, such as dentures and implants, can be options for rehabilitating the oral cavity for patients who have lost teeth. However, defects in the alveolar bone pose a challenge in prosthodontic treatment [1]. Alveolar bone defects can be seen as a deficiency in soft tissue and bone volume in the alveolar process [2]. This can occur due to various factors such as surgical therapy (tooth extraction, tumor and cyst removal), orofacial trauma, periodontal tissue infection, congenital abnormalities, and bone resorption with age [3].

There have been many advances in bone grafting materials, including the use of autografts, allografts, xenografts, polymers, bioactive glass ceramics, and synthetic bone graft materials [4]. Among the various bone grafting materials available, only autogenous bone offers osteogenic, osteoinductive, and osteoconductive characteristics compared to other bone substitute and composite materials. Due to its properties and lack of immunological reaction, autogenous bone grafts are widely regarded as the gold standard and the most efficient material for bone regeneration procedures [5,6]. Currently, researchers and dentists are becoming interested in using human dentin from extracted teeth as a graft

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material to regenerate new bone [7]. The goal of this article is to review and assess the efficacy, advantages, disadvantages, and clinical outcomes of autogenous bone graft materials in dentistry.

2. Material and methods

2.1. Search Strategy

An investigation was conducted in the English language through the utilization of the PUBMED database to discern scholarly studies pertaining to autogenous bone graft materials. The scope of this investigation encompassed research articles and literature reviews spanning the years from 2007 to 2023. The following keywords were searched: autogenous bone graft, autogenous tooth bone graft.

3. Results and discussion

3.1. Definition Of Bone Graft

More than a century ago, various bone substitute materials have been developed and sold. The considerations in choosing a graft material include the source of the material, how the material is obtained from the surgical site, the reason for use, cost, and most importantly, the success of the repair or regeneration process in the involved tissue [8]. Bone grafts are used to treat various disorders, bone fracture unions, congenital pseudoarthrosis, plastic and reconstructive surgery, and bone damage due to trauma, infection, and tumors. Bone graft is a surgical procedure that involves replacing a missing or damaged bone with osteogenic material. The material used for bone graft can be autograft, allograft, xenograft, or synthetic [9]. Bone graft can be performed because bone tissue has the ability to regenerate completely if given the proper conditions and environment to grow. The cells inside the new bone can then seal themselves to the old bone, and the new bone will replace the graft entirely, resulting in the formation of new bone that is integrated [10].

3.2. Physiology Of Bone Graft

The process of bone regeneration from bone graft materials occurs through three main mechanisms, namely osteogenesis, osteoinduction, and osteoconduction. Osteogenesis is the process of new bone formation where the cells responsible for the bone formation originate from either the host or graft material. In osteoinduction, osteoprogenitor cells are encouraged to develop into osteoblasts, which subsequently start the process of creating new bone. This mechanism involves mediators such as active factors, for example, bone matrix protein (BMP). Osteoconduction refers to the mechanism by which the graft material serves as a scaffold, promoting the attachment of osteoblasts and osteoprogenitor cells, as well as the migration of cells for the formation of new bone growth [9,11,12].

3.3. Ideal Characteristic for Bone Graft Material

An ideal bone graft material should have the following characteristics such as biomechanically stable, tailored degradation within an appropriate time frame, offers osteogenesis, osteoinductive, osteoconductive, and support the invasion of blood vessels and bone-forming cells. Autogenous bone graft represents the ideal graft material as it possesses the main characteristics of osteoinductivity, osteoconductivity, and osteogenic. Also, an ideal bone substitute should have high similarity with human cancellous bone, higher bioactivity, and reduce risks to the patient [13,14].

3.4. Indications & Contraindications for Bone Graft

In the field of dentistry, bone graft is widely indicated in various treatments. Some of these include 1) Socket Preservation, which is a treatment after tooth extraction. This procedure is developed to limit the effects of post-extraction resorption, maintain the contour of hard and soft tissue on the ridge, and increase socket filling and bone quality prior to implant placement. The use of bone substitutes can help in preserving a stable ridge volume, thereby facilitating easier implant placement and ultimately optimizing both functional and aesthetic outcomes [15,16]. 2) Dental Implant, a treatment that replaces missing teeth, restores function, and improves aesthetics. Implant placement requires adequate bone volume and good biological bone quality. Therefore, bone graft can be a solution in cases where there is a lack of bone for implant placement [17]. 3) Ridge Augmentation, performed using hard and soft tissue grafting procedures to add volume to the alveolar bone [18]. Autografts, allografts, xenografts, and alloplasts are types of bone grafts that can be used, but dentists should strive to choose good materials to avoid horizontal and vertical bone resorption [19].

Contraindications for surgical procedures using bone grafts include 1) Individuals with medically compromised conditions such as diabetes, radiation, chemotherapy, and antiresorptive medications 2) Smoking 3) Alcoholism 4) Individuals with active infection or dental disease who may get implants 5) Underdeveloped alveolar ridges due to congenitally missing teeth 6) Patients with major bone loss due to periodontal disease 7) Patients with insufficient bone volume due to anatomical limitation [20].

3.5. Autogenous Bone Graft

Autogenous bone graft is widely regarded as the gold standard among graft materials because it possesses osteogenic properties and is capable of fulfilling all three components of the regeneration triad [21]. Autogenous bone graft exhibit an osteogenic, osteoconductive, and osteoinductive substrate for filling bone deficiencies and enhancing fracture-healing. While the iliac crest is frequently utilized as the primary location for harvesting bone grafts, other donor sites such as the proximal part of the tibia, distal end of the radius, distal aspect of the tibia, and greater trochanter can also serve as valuable alternatives [22]. Autogenous bone grafting offers several advantages in comparison to other augmentation techniques. The positive results of autograft bone transplantation, there are still complications of bone grafting, mostly at the donor site [23].

3.6. Donor Site Of Autogenous Bone Graft

The donor site for bone graft harvesting for dental implant placement can vary depending on the surgical procedure and the amount of bone needed. Extraoral donor sites that are available and applied for bone grafting in the oral cavity are the calvaria, tibia, and the iliac crest [24]. Intraoral donor sites provide several advantages, such as easy surgical access, close proximity between the donor and recipient sites, reduced patient discomfort, and lower morbidity compared to extraoral donor, such as lateral zygomatic buttress (crista zygomatico-alveolaris), maxillary tuberosity, mandibular ramus in the retromolar area, mandibular symphysis, mandibular coronoid process, mandibular tori, and dentin from extracted teeth. The selection of a particular donor site is often influenced by several factors, such as the anticipated morbidity associated with that specific site. When choosing a donor site for a surgical procedure, medical professionals consider various aspects to determine the best option [6].

3.7. Advantages and Disadvantages

Autogenous bone grafting is widely considered the preferred option among augmentation techniques due to its numerous advantages. These include shorter healing times, superior bone quality, less expensive, reduced risk of disease transmission or antigenicity, less likely to be rejected by the body, and reliable effectiveness in repairing larger defects or significant bone atrophy [21]. Autogenous tooth bone graft material finds a lot of clinical applications in dentistry, and since it is autogenous, the risk of immune reaction is eliminated [25]. However, the disadvantages of autogenous bone grafting are additional surgery that requires longer operative time and possible donor site morbidity which can causes pain and discomfort at the donor site. Also, the amount invested is limited, graft resorption is unavoidable which can lead to a loss of volume and function, and a secondary defect is generated at the donor site [26,27].

3.8. Autogenous Bone Graft Material from Bone Block

Autogenous bone graft is removed from elsewhere in the body and implanted in the mouth. The iliac section of the pelvis, the chin, and the posterior third molar regions of the jaw are common donor sites for bone grafting. When used as a graft material for the regeneration of maxillary and mandibular deformities, autogenous bone graft has showed some potential. Autogenous bone grafts have proven to be highly successful, with success rates exceeding 95%, even in cases where extensive augmentation procedures using autogenous bone are required to treat severely resorbed jaws. Autogenous bone grafting is a well-established method used to reconstruct the atrophic maxilla and mandible. This technique prepares the jawbone for successful implant prosthetic rehabilitation. In a retrospective four-year analysis of 199 bone grafts of the maxilla and mandible, autogenous bone grafts have demonstrated an impressive success rate of 96.9% [6,25].

3.9. Autogenous Bone Graft Material from Tooth

Tooth-derived bone graft material is a type of autograft, which is one of the four categories of bone graft materials [28]. Autogenous tooth bone grafts share similar attributes to conventional bone grafts regarding their healing potential, physical characteristics, and clinical efficacy. Utilizing autogenous tooth bone grafts has shown promising prospects for successfully regenerating and reconstructing maxillary and mandibular defects. The main uses for autogenous tooth bone grafts are sinus and ridge augmentations and the preservation of the socket before implant placement [25]. Autogenous tooth bone graft material was initially created in 2008 and has mostly been utilized to complement dental

implants through directed bone regeneration. Teeth can be used as a bone graft material due to their inorganic content, which contains four types of calcium phosphate that have an osteoconductive property, making them a biocompatible bone graft material [29]. Autogenous tooth bone graft materials have shown a progressive process of resorption, accompanied by the formation of new bone. This resorption and bone formation occur through the mechanisms of osteoconduction and osteoinduction [30].

Autogenous dentin has been investigated as a potential biomaterial for bone regeneration in recent years. Autogenous dentin possesses ideal physical properties such as density and roughness, and it exhibits positive behavior as a graft material. In a study evaluating the osteogenic potential of autogenous tooth graft used in dental extraction sites, the extracted tooth was used as the source of autogenous bone graft. Research studies have provided evidence that autogenous dentin can serve as an effective bone graft material for enhancing bone healing in extraction sockets and facilitating implant placement. These studies have shown that using autogenous dentin as a graft material leads to acceptable levels of implant stability, minimal marginal bone loss, and low incidences of complications and implant failure [27,31,32,33,34].

3.10. Autogenous Bone Graft For Socket Preservation

Autogenous bone graft is a technique used for socket preservation after tooth extraction. It involves using bone graft material from the patient's own body, typically from the tooth or jawbone, to fill the socket and promote bone regeneration. Autogenous tooth bone graft material and autogenous particulated dentin graft are two types of autogenous bone grafts that have been studied for socket preservation. The study evaluated the effects of autogenous dentin graft on bone healing and found that it was effective in promoting bone formation. Autogenous tooth bone graft material has also been studied for alveolar ridge preservation and has shown good bone remodeling and osteoconductivity. The success rates of autogenous bone graft for socket preservation have been evaluated in several studies. A study comparing the efficacy of dentin autograft with autogenous bone graft for socket preservation found that both techniques resulted in significant bone fill after 6 months, with autogenous bone graft showing slightly better results. Overall, autogenous bone graft has shown promising results for socket preservation and bone regeneration [35,36,37].

3.11. Autogenous Bone Graft For Dental Implant Placement

According to several studies, the implant survival rate for dental implants using autogenous bone grafts is generally very good, an average implant survival rate of 97.9% for autogenous bone block grafts with rates ranging from 95.6% to 100%. The implant survival rate for autogenous bone grafts does not differ significantly from that of guided bone regeneration techniques [38]. A systematic review and meta-analysis showed that the implant survival is consistently higher in bone harvested from intraoral sites compared to extraoral grafts, such as iliac crest [39].

3.12. Autogenous Bone Graft For Ridge Augmentation

According to a retrospective cohort study, autogenous bone grafts have a high success rate of 95.6% for alveolar ridge augmentation [6]. In a case study, block bone autografts taken from the mandibular symphysis were successfully used for localized alveolar ridge augmentation before implant placement. Autogenous bone grafts from the mandibular symphysis can be used for alveolar ridge augmentation [40]. The success rate of guided bone regeneration and autogenous bone grafts for lateral ridge augmentation is high. Lateral ridge augmentation using autogenous bone grafts from bone block and guided bone regeneration has a success rate of 98% [41]. Vertical alveolar ridge augmentation can be achieved by utilizing autogenous bone grafts in combination with platelet-enriched fibrin glue. This approach has been investigated as a viable method for enhancing the height of the alveolar ridge. A study conducted on vertical alveolar ridge augmentation demonstrated that the use of autogenous bone grafts and platelet-enriched fibrin glue, along with simultaneous implant placement resulted in a significant rise in alveolar ridge height. The study reported an average height increase of 4.2 ± 1.0 mm, which accounted for approximately 63% of the initial defect height [42].

4. Conclusion

In conclusion, due to its excellent biological characteristics and high success rates, autogenous bone graft material remains to be the gold standard in dentistry. Autogenous bone grafts involve using a patient's own bone, typically harvested from intraoral or extraoral sites, to regenerate bone in dental implant placement, ridge augmentation, and other reconstructive procedures. The use of autogenous bone grafts also exhibit excellent biocompatibility, eliminates concerns regarding disease transmission, making it a safe and reliable option.

Compliance of ethical standard

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Disclosure of Conflict of interest

We declare that there was no major conflict of this article.

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