

## Alveolar Reconstruction through Autologous Bone Grafts. Current Concepts

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### Abstract

**Objective:** The objective of this work is to obtain a compendium on the current knowledge of bone and its application in the form of autologous bone in the reconstruction of maxillary or mandibular alveolar defects in the field of dental implantology.

**Material and Methods:** A literature review based on prospective, retrospective scientific articles and systematic reviews published in PubMed was carried out.

**Conclusions:** Bone is a highly mineralized tissue in which cells such as osteoblasts, osteoclasts, osteocytes and bone lining cells play a fundamental role. It is formed by several structures among which stand out at the macroscopic level: a compact cortical part and a more porous spongy part which are dependent on the loads to which they are subjected; and on the one hand organic and other inorganic at the microscopic level..

In cases of alveolar bone loss, which can be due to multiple causes, autologous bone has been widely proven to be a predictable material for the reconstruction of alveolar defects in the maxilla or jaw, whether used with block grafts, block grafts laminates or particulate form showing beneficial results when combined with materials such as inorganic mineral bovine bone (ABBM), expanded polytetrafluoroethylene (ePTFE) membranes and resorbable collagen (CM) membranes.

**Keywords:** Bone; Bone Graft; Autologous; Regeneration

### Introduction

In modern dentistry, dental implant rehabilitation has become a successful treatment. This allows the oral surgeon to return the function and aesthetics to the patients. Occasionally there are cases in which the amount of bone required for the three-dimensional placement of the implants is insufficient, which is why it is necessary to use bone regeneration techniques in order to achieve an adequate bone volume for the correct placement of the implants [1]. Despite the difficulties that exist when it comes to reconstructing alveolar defects, autologous bone has proven to be one of the most predictable materials in this field [2].

### Objectives of the Study

The objective of this work is to know the current concepts of bone and its application in the form of autologous bone in the reconstruction of maxillary or mandibular alveolar defects in the field of dental implantology.

### Material and Method

A bibliographic review based on prospective, retrospective scientific articles and systematic reviews published in PubMed between 2003 and 2017 has been carried out.

## Results and Discussion

The oral surgeon at the time of performing autologous bone grafts that allow the placement of dental implants to perform an aesthetic and functional implant-supported rehabilitation must know the bone.

The calcified hard tissues of the body have been widely documented throughout history, being the first articles published on the structure and composition of bones, teeth and calcified tissues of the seventeenth century [3].

Bone is the basic structural unit of the skeletal system of the human being. Being among its functions to support the weight of the body, protect vital organs, exert resistance to mechanical forces, harbor and store hematopoietic cells [3]. The alveolar ridge plays an important role in the support and protection of teeth in the mandible and the maxilla, with a mature alveolar process being formed by 60% inorganic matter, 25% organic matter and 15% water [4].

In a bone there is a macro-structure, being able to observe areas of cortical bone with a porosity of around 6% and areas of cancellous bone which are subject to a certain stress due to compressive forces, presenting a porosity of around 80%, being the normal thickness of the trabeculae between 50 and 300 micrometers with a distribution dependent on the forces to which they are subjected [3].

On the other hand, there is a micro-structure and a submicro-structure in which there are: Havers channels, osteons and lamellae. A nano-structure formed by collagen fibers and, finally, a subnano-structure in which are found minerals, collagen and organic proteins without collagen. Collagen type I is the main element of the organic matrix [3]. Osteocalcin, osteopontin, osteonectin and bone sialoprotein are also found [4]. This collagen is produced by the osteoblasts and between the spaces of the matrix that generates the apatite crystals, biomineralization is called to the formation of apatite between the extracellular spaces of the collagen. Thus forming a structure with mechanical, chemical and biological functions which adapts to the loads to which it is subjected; If the loads are large, there will be a biological remodeling by which the bone becomes stronger, starting with the change of the trabecular structure and thickening the cortical part. However, if the loads to which a bone is subjected are diminished, a process of osteopenia is started with a consequent decrease in bone density caused by few stimuli that generate bone remodeling [3].

When it comes to understanding a bone formation it is important to know that there is a first phase of mineralization which occurs in the first 13 days after the organic matrix is generated, obtaining a 70% mineralization a few days later. The other 30% being mineralized over the years, which is secondary mineralization [3].

From a biological point of view it is known that among the cells that form the bones are mainly: osteoblasts, osteocytes, osteoclasts and coating cells. Osteoblasts are single-core cells, are essential for bone regeneration, and come from osteogenic cells located in bone-covering tissues, the periosteum and the bone marrow. Once the organic matrix is generated and it is mineralized, these cells become osteocytes and remain stored in the bone [3,4]. Being 90 - 95% of the bone cells [4]. Others lodge in the bone surface playing an important role in the bone remodeling becoming coating cells [3].

In a study by Verborgt., *et al.* in 2002 it was shown that osteocytes play an important role in the process of bone remodeling involved in a microdamage in the bone, decreasing the levels of transforming growth factor beta and allowing the formation of osteoclasts [4].

Osteoclasts are differentiated myeloid cells with bone resorption capacity which are activated by the presence of two cytokines (colony stimulating factor 1 (CSF-1) and activator receptor of NF-kB ligand (RANKL)), also influenced by parathormone (PTH), its function is to remove the organic and inorganic part of the matrix thus allowing a new bone deposition [4].

The alveolar bone defects can prevent a correct prosthetic rehabilitation by means of dental implants due to the lack of bone that prevents to carry out a correct three-dimensional placement of the implants [5-7]. The causes of these defects can be diverse and among those that are: edentulism, periodontal disease, pneumatization of the maxillary sinus, acute infections or traumatisms [8]. Studies on autologous bone grafts have been published since the 19<sup>th</sup> century [3]. Autologous bone has proven to be the "gold standard" for the regeneration of both vertical and horizontal bony defects in the jaw or maxilla [9,10]. Being one of the most predictable reconstruction materials due to its biological properties [2]. Autologous bone grafts are characterized by having the following properties: osteoinduction, osteoconductivity and osteogenesis [9].

Osteoinduction was defined in 1931 and results in the induction of osteogenesis in which primitive, pluripotent and undifferentiated cells are stimulated to form cells involved in bone formation. While osteoconductivity is the ability to form a guide on which to generate a new bone [3].

The donor area may be extra-oral, such as the calotte, fibula, ribs or iliac crest, but they are subject to a greater amount of morbidity [9]. The shell is an anatomic donor area with predictable results in alveolar reconstructions in which large amounts of bone are needed [8]. On the other hand, there are intraoral donor areas such as the mandibular symphysis, the external oblique line or edentulous areas, which provide proximity to the operative field, lower morbidity and avoid hospitalization. The donor area can be filled with collagen sponges or one of the two previously obtained sheets can be placed. And in that case there are possibilities to see the external oblique line regenerated after three months [9]. An optimal material to perform graft surgery procedures should provide a correct volume, have a good integration to the operative field to be regenerated, be close to the recipient bed, be a simple graft technique and have little morbidity [8].

There are techniques in which the bone block is obtained from the external oblique line and divided into two finer blocks with a diamond disc following the "split bone block technique" (SBB) to obtain biological grafts in this way. Obtaining large amounts of bone with minimal complications. The mandibular bone blocks are predominantly cortical in nature and have a low amount of cancellous bone, which makes them more resistant to revascularization, therefore they are less likely to regenerate. For this reason, authors divide the block into two sheets and fix them to the receiving bed with microtuneces filling the spaces with autologous bone in the form of particles [9]. The result of the therapeutic procedure by grafts will be successful if the grafts are fixed correctly, thus achieving a correct neovascularization, and in a correct relationship with the soft tissues, which will reduce the chances of bone exposure due to problems in the closure of the soft tissues, which would lead to contamination and partial or total loss of the grafts; a double flap technique in the area to be treated can be carried out to minimize tension and thus promote bone regeneration [8].

However, autologous bony graft techniques have also been described in unlaminated block that can successfully undergo graft resorption, so ePTFE and ABBM membranes have been used to minimize this resorption. One of the disadvantages of these ePTFE membranes is their difficult handling and possible exposure and as a consequence the partial or total loss of the graft due to infection after contamination, so that techniques have also been described in which CMs are used that present a lower barrier capacity over time, easier handling and combined with block bone grafts and ABBM minimize the risk of resorption [5,11-13].

In a study by Stavola and Tunkel in 2013, satisfactory results were obtained in alveolar reconstructions of vertical defects with autologous bone without complications of graft exposure, which are probably due, according to the authors' point of view, to an approach using a flap in the defect tunnel, thus avoiding a crestal incision, decreasing the forces on the graft [14].

In a study by Maiorana, *et al.* in 2005 the success of the use of ABBM covered block grafts with a resorption of 9.3% was demonstrated, while the areas not covered with ABBM showed a reabsorption of 18.3% [11].

Another way to use autologous bone is in a particulate way, in a study by Meloni, *et al.* in 2016 the success of the treatment of horizontal bone regeneration of alveolar ridges on knife edge is demonstrated by a combination of 50% of particulate autologous bone and ABBM and a CM fixed by pins in both vestibular and lingual to achieve fixation until The membrane is reabsorbed so that a large amount of bone can be obtained [12].

Some authors propose that making decortications or perforations in the recipient bed could improve the integration and maintenance of the grafts. However studies with animals have shown the success of these treatments without the decortications [14,15].

Given the risk of tissue damage of certain anatomical structures such as nerves and dental roots in procedures for obtaining an intraoral bone block due to poor three-dimensional control of the osteotomies by the oral surgeon, there is a concept of computer-guided surgery to obtain of the block, always taking into account that the bone block is sufficient to reconstruct the defects in a safe way. Using guided and planned surgery with a computer to obtain the bone block allows to control the angulation and the depth of cut of the osteotomies to optimize the amount of bone required for reconstruction, minimizing the damage of anatomical structures. Improving the effectiveness and predictability of the surgical procedure [2].

In a study by Burkhardt and Lang the relationship between a high tension of the flaps and problems in the healing of the reconstruction is demonstrated, reflecting as non lesive a tension of 5g in relation to the healing of the wound. With tension greater than 5g, there will be problems in healing and with tensions greater than 25g there is a high risk of poor wound healing. Luca de Stavola, *et al.* demonstrate in a study that in cases of maxillary alveolar bone reconstruction the "Suspended external-internal suture" (SEI) suture reduces the marginal tension of the flaps by 87.6%, thus achieving good wound healing, reducing the incidence of complications short and long term either in cases of guided bone regeneration or reconstructions by autologous bone grafts [1].

Luca de Stavola, *et al.* In 2013, they showed a reabsorption of 5.2% four months after autologous bone graft surgery with a horizontal increase without membrane or biomaterial placement, if the bone contour was respected. By placing ABBM and CM at the time of placing the implants, they achieve a greater amount of alveolar bone horizontally at 4 months after implant surgery, clinically and radiologically [13].

### Conclusions

Bone is a highly mineralized tissue in which cells such as osteoblasts, osteoclasts, osteocytes and bone lining cells play a fundamental role. It is formed by several structures among which stand out at the macroscopic level: a compact cortical part and a more porous spongy part which are dependent on the loads to which they are subjected; and on the one hand organic and other inorganic at the microscopic level.

In cases of alveolar bone loss, which can be due to multiple causes, autologous bone has been widely proven to be a predictable material for the reconstruction of alveolar defects in the maxilla or jaw, whether used with block grafts, block grafts laminates or particulate form showing beneficial results when combined with materials such as ABBM, ePTFE and CM.

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