ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 10, Issue, 07, pp. 38344-38350, July, 2020
https://doi.org/10.37118/ijdr.19244.07.2020

RESEARCH ARTICLE OPEN ACCESS

BONE REGENERATION AND MAXILLARY SINUS AUGMENTATION: MAJOR APPROACHES

Rogério Luiz de Araújo Vian[1,2,3], Idiberto José Zotarelli Filho[2,4,*] and Elias Naim Kassis[1,2]

[1]University Center North Paulista (Unorp) - São José do Rio Preto/SP, Brazil
[2] Post graduateandcontinuingeducation (Unipos), Street Ipiranga, 3460, São José do Rio Preto SP, Brazil 15020-040
[3]Santa Casa Hospital-Bucomaxillo Facial Traumatology Center- Ribeirão Preto/SP, Brazil
[4]Zotarelli-Filho ScientificWorkofSao Jose do Rio Preto/SP, Brazil

ARTICLE INFO

Article History:
Received 14th April, 2020
Received in revised form
29th May, 2020
Accepted 06th June, 2020
Published online 30th July, 2020

Key Words:
Sinus lifting, Maxillary Sinus Augmentation, Bone regeneration, Biomaterials.

Corresponding author:
Idiberto José Zotarelli Filho

ABSTRACT

Introduction: The lack of bone in the alveolar edges has been a major problem in the functional aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic tooth extractions, congenital tooth absence, pathologies involving the mandible and mandible, in addition to infections. The filling materials can be hydroxyapatite, lyophilized, and ground demineralized bone marrow, autogenous bone, which is considered the gold standard, among others. The lifting of the maxillary sinus, using bone grafts, has become one of the most frequent procedures in implantologyand also the most investigated by the use of platelet concentrates with or without biomaterials. **Objective:** Carry out a comprehensive review of the literature on the main processes and biomaterials related to sinus lifting and bone regeneration. **Methods:** The present study followed a systematic review model. After literary search criteria using the MeSH Terms that were cited in the item below on "Search strategies", a total of 58 clinical studies were compared and submitted to the eligibility analysis, and, after that, 36 studies were selected, following the systematic review rules - PRISM. The search strategy was carried out in the databases Medline, Embase, Pubmed, Ovid, and Cochrane. **Major findings and conclusion:** Due to bone regeneration and biological barriers in graft surgeries, there has been a technological growth in these materials as they point out as potential tools for treating bone losses. The lifting of the maxillary sinus, using bone grafts, has become one of the most frequent procedures in implantology and also the most investigated by the use of platelet concentrates together with autogenous or allogeneic bone, as well as with the use of polymeric biomaterials.

Citation: ***Rogério Luiz de Araújo Vian, Idiberto José Zotarelli Filho and Elias Naim Kassis.*** "Bone regeneration and maxillary sinus augmentation: major approaches*", International Journal of Development Research*, 10, (07), 38344-38350.

INTRODUCTION

In recent years, the number of dental implant procedures has been increasing worldwide, reaching around one million dental implants per year (Pye, 2009; Branemark, 1977). In Brazil, in recent decades, there has been a very rapid evolution in implantology with high success rates (Bugarin Júnior, 2007). The development of biomaterials for use in dental clinics in recent years has represented a powerful therapeutic tool in the correction of bone defects (Bugarin Júnior, 2007). However, despite the proven benefits, its use requires careful clinical and ethical care from the professional in the analysis of the risks and benefits that each biomaterial may present. A study with 123 dental surgeons who use biomaterials showed that professionals are unaware of the risks and benefits of biomaterials, nor of their biological principles since 45% believe there is no risk to the patient and 56% do not consider biomaterial as a medicine. About 70% felt safe about their origin (Bugarin Júnior, 2007). Despite this, 96% of respondents said that there should be greater control by health authorities. More than half of the interviewees (51%) reported little or no participation by the patient in the therapeutic choice process (Bugarin Júnior, 2007). Many patients, elderly or not, sought implant-supported rehabilitation, but there is a need for some adjustments that lead to the consequent demand for regenerative procedures for maxillary reconstructions (Busetti, 2015). These patients can often have pathological changes, or use medications, which can alter bone healing (Busetti, 2015). Several materials can be used as bone grafts, each with different properties; for example: regarding neovascularization, materials such as hydroxyapatite and calcium phosphate showed the highest rates of expression of vascular growth factors (VEGF) and microvascular density; while polymer grafts showed the lowest rates (Saghiri, 2016). The search for a solution for large bone defects, studies based on guided tissue regeneration therapy, or guided bone regeneration have started. These studies promote the use of filling materials and epithelial barriers that assist in the treatment as an accessory for bone graft techniques. Thus, they favor greater predictability in alveolar and peri-implant reconstructions and have a good prognosis (Mazaro, 2014).

The main problem is with the non-absorbable membranes, as they need a second surgical act, they cause infections if there is any type of exposure; they have a firm consistency, which makes it difficult to adapt to the bone defect and thus impair blood supply and can cause tissue dehiscence and necrosis (Busetti, 2015; Fernandes, 2015; Costa, 2016). Guided bone regeneration (ROG) favors the formation of new bone tissue and prevents the gingival tissue from invading into the space between the bone and the implant (Busetti, 2015; Fernandes, 2015). Covani *et al*., (2012), in a 10-year prospective study comparing patients who received the ROG technique, with patients who did not, indicated the possibility of gingival retraction in the group that did not receive the technique when compared to the group that received (Mazaro, 2014).

The filling materials can be hydroxyapatite, lyophilized, and ground demineralized bone marrow, autogenous bone, which is considered the gold standard, among others. In conjunction with the filling materials, it is often necessary to use resources to isolate the implant using biological membranes, which are epithelial barriers that guide tissue regeneration, act as a mechanical barrier separating periodontal tissues from bone or implant surface, thus promoting bone neoformation, containment of the filling material and graft stability (Fernandes, 2015; Saghiri *et al*., 2016). Therefore, the present study aimed to conduct a comprehensive review of the literature on the main processes and biomaterials related to sinus lifting and bone regeneration.

METHODS

Study Design: The present study followed a systematic review model. After literary search criteria using the MeSH Terms that were cited in the item below on "Search strategies", a total of 85 clinical studies were compared and submitted to the eligibility analysis and, after that, 39 studies were selected, following the systematic review rules – PRISMA (Transparent reporting of systematic reviews and meta-analyzes-http: //www.prisma-statement.org/).

Search Strategy and Information Sources: The search strategy was carried out in the databases Medline, Embase, Pubmed, Ovid and Cochranefollowed the following steps: - search by MeSH Terms: *Sinus lifting. Maxillary Sinus Augmentation. Bone regeneration. Biomaterials*, and use of Booleans "and" between mesh terms and "or" among historical findings (Figure 1).

Risk of Bias: According to the Cochrane model for the risk of bias in the present study, the global assessment resulted in 4 studies with a high risk of bias and 8 studies with uncertain risk. In addition, there was an absence of the funding source in 4 studies and 5 studies did not disclose information about the declaration of conflict of interest.

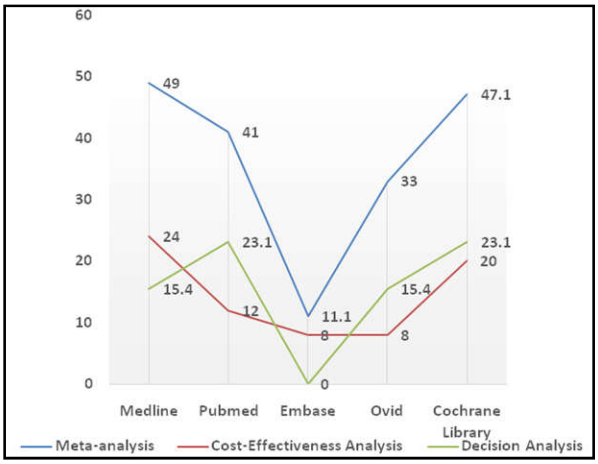

Figure 1. Percentage quantification of recent works published in the journals mentioned, broken down by meta-analysis and decision analysis.

Development – Epidemiology: According to data from the Brazilian organ transplant association, the number of bone transplants per million of the population reaches 450 (18,200 transplants) in the State of São Paulo, 110 (4,100 transplants) in the State of Paraná and 30 (1,200 transplants) in the State Rio de Janeiro, made available by the 5 Fabric Banks of the 3 States, during the 10 quarter of 2012 (Hallman, 2001). The lack of bone in the alveolar edges has been a major problem in functional aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic tooth extractions, congenital tooth absence, pathologies involving the mandible and mandible, in addition to infections, due to the emotional consequences and the possibility of deformity and also the economic impact they cause on the National Health System (SNS) (Fontanari *et al*., 2007; Hallman, 2001). Bone loss can also occur due to periodontal disease, traumatic surgeries, or even due to physiological reasons due to the lack of rim function or inadequate prosthetic load (Hing, 2004). Trauma in the face region can affect both soft tissues (skin, muscles, nerves) and hard tissues (bones, teeth), so these injuries can affect the quality of life, as well as the victim's health (Hing, 2014).The maxillofacial injury trauma can be considered one of the most devastating aggressions found in traumatology and oncology, due to the emotional consequences and the possibility of deformity and, also, to the economic impact they cause on the National Health System (NHS) (Langer, 1993; Lima, 2008; Zago, 2006; Maiorana *et al*., 2008). The face, more than any other region of the body, is affected by aesthetic changes, since it is always visible, and the damage is immediately perceived (Mazzoneto, 2009). For this reason, facial trauma deserves to be highlighted in the treatment of multiple trauma due to its high incidence and severity.

The Bone Regeneration Process: The microscopic bone structure consists of osteoprogenitor cells, supporting cells (osteoblasts and osteocytes), remodeling cells - osteoclasts - and a non-mineralized extracellular matrix called osteoid, composed of type I collagen and non-collagen proteins such as osteonectin, osteocalcin, bone morphogenetic protein (BMP), glycosaminoglycans (GAG) and bone sialoproteins (Simonpieri, 2012). Osteoprogenitor cells are small spindle cells found on all non-resorbable bone surfaces, derived from primitive mesenchymal cells and form a population and precursor cells that can differentiate into more specialized cells such as osteoblasts and osteocytes (Langer, 1993).

The regeneration of composite tissues such as periodontal tissue has also been demonstrated, proving that adipose mesenchymal stem cells associated with platelet-rich plasma can regenerate alveolar bone, cementum, and periodontal ligament eight weeks after implantation (Nardi, 2006; Locke, 2009). Clinically, there is a combined study of bone graft with fibrin glue, a biodegradable biomaterial, and adipose mesenchymal stem cells for the reconstruction of a large bone defect in the skullcap of a seven-year-old trauma victim (Nardi, 2006). Osteoblasts are derived from undifferentiated stem cells, being responsible for the production of bone matrix, rich in collagen (mainly type I), and essential for later mineralization, by adherence of crystals of calcium hydroxyapatite, magnesium, potassium, sodium, and carbonate in collagen fibrils (10.20). Osteoblasts are also rich in alkaline phosphatase, which has a high value during periods of bone formation. The process of formation of new bone mediated by osteoblasts is calledosteogenesis (Calasans, 2011). It is known that osteoblasts bind directly to collagen through integrin-RDG interaction sites (Arginine-Gllicina-Aspartate).

The osteoinduction process is influenced by several factors and consists of the induction of mesenchymal stem cells from adipose tissue into osteoprogenitor cells (Langer, 1993; Mesimäki, 2009). Osteogenic differentiation requires the presence of inducers, which include β-glycerolphosphate, ascorbic acid, and dexamethasone (Mesimäki, 2009). In the presence of these substances, mesenchymal cells acquire the morphology and components of osteoblast membranes and start to express alkaline phosphatase, depositing extracellular matrix rich in calcium and certain proteins, such as osteopontin and osteocalcin (Mesimäki, 2009). Organic phosphates, such as β-glycerolphosphate, provide osteogenesis for their role in mineralization and modulation of osteoclast activity (Langer, 1993). Thus, free phosphates can induce mRNA and protein expression, exemplified by the osteopontin protein. If organic phosphate, for example, β-glycerolphosphate is present, there is the formation of mineral content, hydroxyapatite that is formed between the collagen fibers (Liu, 2010). Other compounds, such as phosphate ascorbic acid, are also used in osteogenic induction, in the involvement of increased alkaline phosphatase activity and in promoting the production of osteocalcin and osteopontin (Mesimäki, 2009; Fardin, 2010).

Bone morphogenetic proteins (BMP) function as growth factors with a specific role in the proliferation and differentiation of mesenchymal stem cells from adipose tissue (Zago, 2006; Vacanti, 1999). BMP-4 is involved in the early stages of osteogenesis, in addition, it has been shown that differentiation of human mesenchymal stem cells in the osteogenic lineage requires the presence of BMP-4 in the first days of culture and that these cells, after 21 days express osteogenic specific proteins such as osteonectin, osteocalcin, and osteopontin (Vacanti, 1999). There are three fundamental parameters in bone tissue engineering that will determine the ability of osteoinduction to be the presence of soluble osteoinductive signals, the viability of undifferentiated mesenchymal stem cells to respond, to have the ability to differentiate into bone-forming cells and extracellular matrix production appropriate (Vacanti, 1999). Tissue engineering includes numerous advantages that meet the needs of the injured tissue or organ for the regeneration process (Gimble, 2013; Zago, 2006). For this, it is necessary to understand chemical, physical, and biological processes, both biological material and the biological niche of the host (Hallman, 2001). The crossing of compatible information between microenvironments enables cell recognition and signaling cascades for neovascularization (Hing, 2004). Another advantage is the minimally invasive surgical intervention, that is, it allows the use of faster surgical techniques that cause less risk to the patient (Mazzoneto, 2009). Thus, tissue engineering is a tool that enables, through an appropriate biological niche, the construction and regeneration of any tissues and organs (Maiorana, 2003; Fardin, 2010). For this, xenografts, autografts, and allografts are used, with and without the use of cells (Hallman, 2001; Hing, 2004). According to the Conference of the National Institute of Health Consensus Development in 1982, biomaterials are beneficial organic compounds or the combination of them, that can be used for a period of time, completely or partially as part of a system that treats, increases or replaces any tissue, organ or function of the human body (Maiorana, 2003; Fardin, 2010; Tejero, 2014). The great challenge is to understand that the science of biomaterials is multidisciplinary and its application requires adjustments to its processing, sterilization and structural modifications to favor the interaction with the tissue of interest. Bioengineering and cell therapy work together for Regenerative Medicine, favoring, and improving biological conditions to accelerate tissue repair and regeneration and, thus, naturally maintaining tissue homeostasis (Lima, 2008).

This condition is maintained because the required cellular elements, cell proliferation, and differentiation factors and supramolecular structures are provided that guarantee the functional stereochemical organization of the tissues generated and their systemic integration (Maiorana, 2003; Fardin, 2010; Tejero, 2014). Normal bone formation and tissue restoration involve coordinated interaction between bone-forming cells and biological signals (Nardi, 2006). The main force in this process is the osteoblasts and their precursors, the stem cells of the adipose tissue (Simonpieri, 2012). Osteoblasts can produce new bone, along with biomaterials, and can initiate the release of biological signals that guide the bone formation and remodeling (Fontanari, 2007). These biological signals attract mesenchymal cells and other bone-forming cells to the receptor site, stimulating the differentiation of mesenchymal cells into osteoblasts (Vacanti, 1999). Growth factors and other proteins are some biological signs that may be involved in new bone formation and tissue remodeling.

In addition, through chemotaxis, there is a migration of bone-forming cells to the application area, as stimulation of cell migration occurs in response to chemical stimuli (Vacanti, 1999). Mesenchymal stem cells, osteoblasts from bleeding bone, muscle and periosteum infiltrate the biomaterial implanted in the grafted area. BMG binds to specific receptors located on the surface of mesenchymal stem cells and promotes their differentiation into bone-forming cells (Vacanti, 1999). Monocytes, macrophages, and endothelial cells contribute to bone remodeling, either by contact with osteogenic cells or by the release of soluble factors such as cytokines (Simonpieri, 2012). In the skeletal system, the tumor necrosis factor (TNF-α) stimulates bone and cartilage reabsorption and inhibits the synthesis of collagen and proteoglycans. Interleukin 1 (IL-1) induces the expression of a wide variety of cytokines. IL-6 are molecules that are known to stimulate the differentiation of mesenchymal progenitor cells into the osteoblastic lineage, they are also potent anti-apoptotic osteoblast agents. In bone, the main sources of IL-6 are osteoblasts and not osteoclasts. Prostaglandin E2 (PGE2) is also directly related to the expression of the cytokine IL-6 (Vacanti, 1999).

Main Biomaterials: It is used to direct, by controlling interactions with components of a living system, the course of a diagnostic or therapeutic procedure, whether in humans or animals. Checking the history of biomaterials in the medical and dental field, numerous researches have been carried out in the search for natural or synthetic substances that can replace body tissues, soft or hard, and lost (Carvalho, 2010). Thus, ancient records show us the use of substances, such as ivory. Dry bone, gold, gold wire, silver alloys, among other materials. As of 1800, synthetic compounds have been used for bone replacement, when researchers advocated the use of calcium sulfate in bone defects (Carvalho, 2010).Thanks to the great technological development of biomaterials, associated with the advancement of knowledge about the biology of bone tissues, it became possible to selectively influence the bone formation, controlling the quality and quantity of bone inside oral structures (Carvalho, 2010). Thus, there is a wide variety of biomaterials, synthetic or biological, on the market, with various particle sizes and mainly classified according to their mode of action: osteoconduction, osteoinduction, or osteogenesis. In implantodontics, the installation of implants should be used as a complementary therapy, is necessary to know the biological potential of each material, to indicate it in the different clinical situations (Carvalho, 2010). We can find on the market a varied range of biomaterials, such as demineralized lyophilized bone, inorganic bone, and bioactive glass. These biomaterials must have precise indications and must not demand an unrealistic biological demand from them. It is known that bone neoformation is a biological process that takes place at the expense of osteoblastic activity and that the quality of neoformed tissue when in the presence of these biomaterials, is not the same for everyone, and depends on the material, its origin, the clinical conditions the recipient site, the domain of indications and the surgical technique (Carvalho, 2010).

The implantodontist's concern after extraction is bone loss in the volume of the socket (Carvalho, 2010; Pereira, 2013; Caballé-Serrano, 2015). When it is not possible to install immediate implants, after extraction, the alveolar process, depending on the thickness of the vestibular bone plate at the end of the bone remodeling process, may present depression on the vestibular surface, which would imply the need for autogenous bone graft en bloc (Caballé-Serrano, 2015). In a study carried out in 1967, it was observed that in the anterior maxilla there is a loss of 25% of bone volume in the first year after extraction. In the posterior region, it is twice as large as in the anterior maxilla (Merli *et al*., 2014). It is believed that if the bone defect has five walls (alveoli with intact walls), the alveolar bone repair will have occurred naturally. However, if the normally vestibular alveolar wall is less than 1.5 mm thick or absent, the professional should use intra-alveolar materials (autogenous bone, mineralized bone or alloplastic material), associated with membranes that improve the predictability of restoration of the original bone contour in the alveolar process (Moschouris, 2016). There is an indication of the technique called Bio-col for the preservation of alveolar bone walls. The author uses Bio-oss® (inorganic material of bovine origin), as an osteoconductive material that, according to the author's understanding, is slowly reabsorbed and replaced by vital bone (Maiorana, 2003). If the bone defect is greater than 2/3 of the buccal wall, reconstruction should be done with autogenous bone. The authors evaluated in dogs the action of two types of bioactive glass particles in mandibular alveoli after extraction and concluded that both Biogran and Biosilicate preserve the alveolar bone height and allow the installation of implants, which osseointegrate (Caballé-Serrano, 2016). As for the use of bone-guided regeneration, a study proves the bone edges after extraction with and without the use of biological membranes. After six months, they observed a bone crest loss of 0.38 mm versus 1.50 mm and horizontal ridge resorption of 1.31 mm versus 4.56 mm respectively. For better predictability of the guided bone regeneration technique, there is a requirement that the membrane is fully protected by the mucoperiosteal flap, and that, in the presence of teeth, it must be at least 1 mm away from the periodontal space (Saghiri, 2016). It is also necessary that the biological space is maintained by the memory of the membrane, or even that the membrane is supported by the bone structure of the interdental septa, or by the remainder of the alveolar bone walls. If this condition does not exist, particulate autogenous bone, mineralized, or synthetic biomaterial can be used (Fujioka-Kobayashi, 2016).

In bone defects with four walls, the indication of reconstruction falls on the autogenous bone or bone mineralized with a membrane. Being able to use the Mischch technique, which seals the alveolus with tissue composed of mucosa and trabecular bone obtained from the maxillary tuber with the aid of a 6.0 to 10.0 mm diameter trephine drill (Dai, 2015).On the other hand, bone defects with two or three walls require that the biomaterial to be used to reconstruct is the autogenous bone combined with the use of biological membranes (Dai, 2015). The bone defect of a wall, on the other hand, requires a block graft with fixation by means of screws. Based on the work of several authors, the installation of implants in areas reconstructed with any biomaterial should be 4 to 6 months (Dai, 2015). There are cases in which the remaining bone tissue is sufficient to stabilize the implant, but there is a deficiency in the vestibular ridge contour that causes partial dehiscence of the vestibular bone plate when the implant is installed. Biomaterials are used in order to improve the contour of the rim, consequently the harmony of the prosthesis (Carvalho, 2010; Caballé-Serrano, 2015; Merli, 2016; Moschouris, 2016). Biomaterials most suitable for improving the rim contour are inorganic ones, which maintain the volume and are not reabsorbed. When these biomaterials are used, biological membranes must be used to protect the area and prevent detachment of the biomaterial (Merli, 2016; Moschouris, 2016; Caballé-Serrano, 2016). It is observed the incorporation of the material in the receiving bed and the stabilization of the material by fibrosis or next to the adjacent soft tissue. There can be no exposure of the biomaterial to the oral environment. What would cause its contamination and the failure of the surgical procedure (Caballé-Serrano, 2016; Saghiri, 2016)?. Particulateautogenous bone can also be used, being biologically more favorable, the area should be well selected with thick and keratinized gingival tissue. When the implant is opened, part of the material is observed next to the gingival tissue and part constituting a mass adhered to the bone (Fujioka-Kobayashi, 2016). The authors performed a histological study in humans and concluded that the spontaneous repair of the peri-implant defect happens when the space between the implant and the bone wall is up to 2.0 mm. It has been shown that 25% of sites that had gaps greater than 2.0 mm noticed compared to 78% of gaps less than 2.0 mm (Merli *et al*., 2016).

Peri-implant bone defects in immediate implants extraction, less than 2.0 mm, does not need to be filled, as spontaneous repair will occur. But if the gap is greater than 2.0 mm, space must be filled in association with biological membranes (Moschouris, 2016). In this case, the biomaterials in the form of particles are trapped by the bone walls, being able to make use of both demineralized, mineralized materials, bioactive glass, or particulate autogenous bone. It is intended to fill the space with newly formed bone, and for this reason, the material used must have osteoconductive properties; avoid the peri-implant bone defect, which is more worrying in the anterior maxilla region, due to aesthetics; preserve the height of the alveolar process, including the interdental septa and raise the maxillary sinus membrane, or sinus graft (Fujioka-Kobayashi, 2016; Dai, 2015).

Maxillary Sinus Lifting: The autogenous bone in the form of a block is indicated for the use of homogeneous, heterogeneous, or alloplastic materials. Most used donor areas are iliac crest, skullcap, mentor oblique line. It is suggested that for total reconstructions, the most indicated would be: iliac crest and skullcap. When the reconstruction encompasses height and thickness simultaneously, the iliac crest is the most indicated (Carvalho, 2010). For thick reconstruction, the skullcap is more advantageous because there is little graft remodeling during the repair period; the bone quality is more suitable for implant installation; for the preoperative period having the minimum of symptoms and for the shorter hospital stay. For partial reconstructions, with individual losses or two dental elements, the oblique line can be indicated, and, in the loss of up to four elements, the chin would be the most appropriate indication (Carvalho, 2010). The lifting of the maxillary sinus, using bone grafts, has become one of the most frequent procedures in implantologyand also the most investigated by the use of platelet concentrates. Another reason lies in the fact that it is a good model for assessing bone remodeling as it is a closed and protected cavity where interference with the oral environment is minimal (Simonpieri, 2012; Tejero, 2014).

Many studies have stated that the addition of platelet-rich plasma to a bone graft is associated with positive clinical results, being a good method of handling the bone graft during insertion into the maxillary sinuses and stimulating bone regeneration around the implants placed in the graft. However, it is difficult to highlight the conclusions of the studies carried out due to the large variables present in the in vivo models, in general, the authors state that the quality of the bone formed and that the surgical technique used do not have therapeutic advantages (Simonpieri, 2012; Tejero, 2014).

Guided bone regeneration is the technique that uses osteopromotion as a biological principle. It is indicated for bone regeneration in fresh alveoli, bone defects that have remaining bone walls, to promote bone neoformation around implants installed immediately after extraction, to correct bone loss (Peri-implant) that occurred after osseointegration (Carvalho, 2010). It is used to correct defects, when it is desired, to increase bone volume, for this it is necessary that the tissue recompose cells with characteristics of the region without interference from the connective tissue (Pereira, 2013). Guided tissue regeneration promotes selective cellular response without producing an inflammatory reaction. Its use has a degree of specificity to the type of tissue where it will be performed (Pereira, 2013).

DISCUSSION

Based on literary findings, both non-absorbable and absorbable membranes are effective in the bone regeneration process. Absorbable do not require a second surgical procedure (Caballé-Serrano, 2015; Merli, 2016). However, there are information gaps, and further research is needed to ensure perfect knowledge of the properties of physical barriers to achieve perfect bone regeneration of periodontal bone defects and around implants (Caballé-Serrano, 2015; Merli, 2016). In this context, the use of biomaterials and membranes contributes to an optimized outcome in rehabilitation with osseointegrated implants. Another 3-year prospective study in patients who received platform switching implants indicated the predictability of the technique associated with guided bone regeneration for reconstruction of the aesthetic area (Merli, 2016).

In a 10-year prospective longitudinal study, they indicated the possibility of gingival retraction in a group of patients who did not receive guided bone regeneration, when compared with a group of patients who received the guided bone regeneration technique. Regarding the use of biomaterial, clinical studies have shown the technique's predictability (Merli, 2016; Moschouris *et al*., 2016). Another work showed in a controlled and randomized clinical study, indicated that the guided bone regeneration technique using different biomaterials (Bone Ceramic / Bio-Oss®), presented predictability and that both materials are suitable for preserving the interproximal bone width and height of the alveolar ridge (Maiorana, 2003; Zotarelli Filho, 2013). Another important aspect in the making of a provisional implant-supported prosthesis, since this prosthesis has several functions such as the adaptation of the patient, choice of color and shape, allowing gingival conditioning, which in addition to obtaining aesthetics, such conduct represents the less clinical time for the prosthetic during the final restoration phase (Merli *et al*., 2016; Caballé-Serrano, 2016).

In addition, gingival conditioning allows adjacent soft tissues to be targeted during the osseointegration phase, eliminating gingival targeting maneuvers for aesthetics (Caballé-Serrano, 2013). The use of biomaterials in Dentistry occurs on an increasingly broad scale. Several types of research have demonstrated the synthesis of new biomaterials applied in all areas of Dentistry with promising results (Caballé-Serrano, 2015; Merli, 2016; Moschouris, 2016). Thus, the use of biomaterials at the clinical level must essentially undergo analysis throughout its scientific evaluation pathway, ranging from in vitro laboratory tests to longitudinal clinical studies in vivo. Thus, the development of bioceramics and prostheses made of these materials must occur under the same conditions of interdisciplinarity that determine the development of any other dental material (Mazzoneto, 2009). In addition, there is a need for the Dental Surgeon to know all the properties mentioned here, so that there is a critical discussion about the use of biomaterials, avoiding only commercial information, which is often incomplete and superficial (Mazzoneto, 2009; Merli, 2016). The opportunity to discuss the use of biomaterials in Dentistry, through the science of dental materials, expands the knowledge of this theme for professionals and researchers (Mazzoneto, 2009). The diversity of applications of biomaterials, as well as their chemical, physical, biological, and morphological differences, makes research in this area of knowledge work with eminently interdisciplinary characteristics. Within this context, professionals in the field of Materials Engineering can contribute significantly to the evolution of this area and to the increase in the range of its applicability, through the development of new and effective biomaterials and also in elucidating the mechanisms that govern the bone regeneration (Merli, 2016; Moschouris, 2016; Caballé-Serrano, 2016; Saghiri, 2016).

Conclusion

Due to bone regeneration and biological barriers in graft surgeries, there has been a technological growth in these materials as they point out as potential tools for treating bone losses. The lifting of the maxillary sinus, using bone grafts, has become one of the most frequent procedures in implantology and also the most investigated by the use of platelet concentrates together with autogenous or allogeneic bone, as well as with the use of polymeric biomaterials.

Competing interests: The authors declare that they have no competing interests.

Funding: Not applicable.

REFERENCES

Aubin J. E., Liu F. The osteoblast lineage. In: Bilizekian, J., Raisz, L., and Rodan, G., editors. Principles of Bone Biology. San Diego, CA: Academic Press: 1996, 39-50.

Branemark PI, Hansson BO, Adell R, Breine U, Lindstrom J, Hallen O. *et al*. 1977. Osseointegrated implants in the treatment of edentulous jaw. Experience from a 10-year period. *Sc and J Plast Reconstr Surg Suppl* 16:1–192.

BugarinJúniorJG, Garrafa II V. 2007. Bioethics and biosafety: the use of biomaterials in dental practice. *Rev Saúde Pública*., 41(2):223-8.

Busetti J. 2015. Avaliação histológica e histomorfométrica da regeneração óssea guiada sob membranad)s biológicas não reabsorvíveis em ratas osteoporóticas com e sem tratamento com ácido zoledrônico ; Porto Alegre.

Caballé-Serrano J, Sawada K, Miron RJ, Bosshardt DD, Buser D, Gruber R. 2016. Collagen barrier membranes adsorb growth factors liberated from autogenous bone chips. *Clin Oral Implants Res.*, Jan 28.

Caballé-Serrano J, Sawada K, Schuldt Filho G, Bosshardt DD, Buser D, Gruber R. Bone Conditioned Medium: Preparation and Bioassay. J Vis Exp. 2015 Jul 8; (101):e52707.

CalasansMD., Fernandes GVO., Granjeiro, JM. Preservação alveolar com enxertos após exodontias e previamente à instalação de implantes. RevistaImplantnews, 2011, 6: 583-590.

Carvalho PSP, Rosa AL, Bassi APF, Pereira LAVD. Biomateriais aplicados a implantodontia. Revista Implantnews 2010;7 (3a-PBA):56-65.

Chan, YL., King, NM. Use of focused íon bean milling for investigating the mechanical properties of biological tissues: A study of human primary molars. Journal of the MechanicalBehavior of Biomedical Materials 2009, 2 (4) : 375-383.

Costa JBZ, Silva F, Dultra CA, Souza LF, Santos MCNE ; Uso de membranas biológicas para regeneração óssea guiada em implantodontia – uma revisão de literatura - Revista Bahiana de Odontologia. 2016 Mar;7(1):14-21.

Covani U, Chiappe G, Bosco M, Orlando B, Quaranta A, Barone A. A 10-year evaluation of implants placed in fresh extraction sockets: a prospective cohort study. J Periodontol 2012; 83(10):1226-34.

Dai Z, Shu Y, Wan C, Wu C. 2015. Effects of pH and thermally sensitive hybrid gels on osteogenic differentiation of mesenchymal stem cells. J Biomater Appl. 29:1272-83.

Fardin A.C., *et al*. Enxerto Ósseo em Odontologia: Revisão de Literatura. InnovImplant J, BiomaterEsthet, São Paulo, 2010, 5 (3): 48-52.

Fernandes TBG. 2015. Utilização de membranas absorvíveis e não absorvíveis em técnicas de regeneração óssea na implantodontia ; Uberlândia.

Fontanari LA., Manne JM; Junior WT. 2007. Utilização de enxerto homógenos para reconstrução em áreas atróficas pré-implante: banco de ossos. *Revista Implantnews,* 5 (6) : 539-597.

Fujioka-Kobayashi M, Sawada K, Kobayashi E, Schaller B, Zhang Y, Miron RJ. 2016. Recombinant Human Bone Morphogenetic Protein 9 (rhBMP9) Induced OsteoblasticBehaviour on a Collagen Membrane Compared Withrh BMP2. *J Periodontol.,* Jan 11:1-14.

Gimble JM., Katz AJ., Bunnell BA. Adipose-Derived Stem Cells for Regenerative Medicine. Circ Res; 2013, 100:1249-1260.

Hallman M, Cederlund A, Lindskog S, Lundgren S, Sennerby L. 2001. A clinical histologic study of bovine hydroxyapatite in combination with autogenous bone and fibrin glue for maxillary sinus floor augmentation. Results after 6 to 8 months of healing. *Clin Oral Implants Res.,* Apr;12(2):135-143.

Hing K. A. 2004. Bone repair in the twenty-first century: biology, chemistry or engineering? Philos. Trans. R. Soc. Lond. B. Biol Sci., 362(1825) : 2821-2850.

Langer R. ;Vacanti JP. 1993. Tissue Engineering. Science 260 : 920-926.

Lima, A F. 2008. Martorelli. Enxertos ósseos: características de alguns materiais. Revista ABO Nacional, 16(3).

Liu, Y., Clark, RAF., Huang, L., Rafailovich, MH. 2010. Hyaluronic acid-gelatin fibrous scaffold produced by electrospinning of their aqueous solution for tissue engineering applications. In Advances inMaterial Design for Regenerative Medicine, Drug Delivery and Targeting/ Imaging., 1140 :131-136.

Locke M, Windsor J, Dunbar PR. Human adipose-derived stem cells: isolation, characterization and applications in surgery.**ANZ J Surg**, 2009, 79:235-244.

Maiorana C, Sommariva L, Brivio P, Sigurtà D, Santoro F. 2003. Maxillary sinus augmentation with anorganic bovine bone (Bio-Oss) and autologous platelet-rich plasma: preliminary clinical and histologic evaluations. *Int J Periodontics Restorative Dent.,* Jun;23 (3) : 227-235.

Mazaro JVQ, Godoy PAI, Junior JFS, Mello CC, Pellizzer EP, Zavanelli AC. 2014. Regeneração óssea guiada em implantodontia: relato de caso ; RFO, Passo Fundo, v. 19, n. 1, p. 121-128, jan./abr.

Mazzoneto, R. Reconstruções em Implantodontia – Protocolos clínicos para o sucesso e aprevisibilidade. Ed. Napoleão, 2009, 1ª Edição. Nova Odessa – SP, Brasil.

Merli M, Merli I, Raffaelli E, Pagliaro U, Nastri L, Nieri M. 2016. Bone augmentation at implant dehiscences and fenestrations. A systematic review of randomised controlled trials. Eur J Oral Implantol. 2016 Spring;9(1):11-32.

Mesimäki K, Lindroos B, Törnwall J, Mauno J, Lindqvist C, Kontio R, Miettinen S, Suuronen R. 2009. Novel maxillary reconstruction with ectopic bone formation by GMP adipose stem cells. *Int J Oral Maxillofac Surg.,* 38 :201-209.

Moschouris P, Retzepi M, Petrie A, Donos N. 2016. Effect of Wnt3a delivery on early healing events during guided bone regeneration. *Clin Oral Implants Res.,* Mar 27.

Nardi N.B., Meirelles S.L. 2006. Mesenchymal stem cells: isolation, in vitro expansion and characterization. HEP 174 : 249-82.

Pereira IKC, Fernandes JRS, Melo ITS. Uso de membranas como barreiras protetoras de enxertos ósseos utilizados na implantodontia. Caderno de Ciências Biológicas e da Saúde. Boa Vista, n. 03, 2013.

Pye AD, Lockhart DEA, Dawson MP, Murray CA, Smith AJ. 2009. A review of dental implants and infection. *J HospInfect*; 72:104–110.

Saghiri MA, Asatourian A, Garcia-Godoy F, Sheibani N. 2016. The role of angiogenesis in implant dentistry part II: The effect of bone-grafting and barrier membrane materials on angiogenesis. *Med Oral Patol Oral Cir Bucal*., Mar 31:0.

Saghiri MA, Asatourian A, Garcia-Godoy F, Sheibani N. The role of angiogenesis in implant dentistry part II: The effect of bone-grafting and barrier membrane materials on angiogenesis. Med Oral Patol Oral Cir Bucal. (2016), doi:10.4317/medoral.21200.

Simonpieri, A., *et al*. (2012). Current Knowledge and Perspectives for the Use of Platelet-Rich Plasma (PRP) and Platelet-Rich Fibrin (PRF) in Oral and Maxillofacial Surgery Part 2: Bone Graft, Implant and Reconstructive Surgery Current Pharmaceutical Biotechnology, 13, pp. 1231-1256.

Tejero, R., Anitua, E. eOrive, G. (2014). Toward the biomimetic implant surface: Biopolymers on titanium-based implants for bone regeneration. Journal of Progress in Polimeral Science, 39, pp. 1406-1447.

Vacanti, JP., Langer, R. Tissue engineering: The design and fabrication of living replacement devices for surgical reconstruction and transplantation. Lancet,1999; 354: 32–34.

Zago, MA., Covas, DT. 2006. Células-tronco: Origens e Propriedades. In: Células-tronco: A nova Fronteira da medicina. Ed. M. Zago e D. T. Covas, pp. 3-20. Editora Atheneu São Paulo.

Zotarelli Filho IJ, Frascino LF, Greco OT, Araujo JDD, Bilaqui A, Kassis EN, Ardito RV andBonilla-Rodriguez GO. Chitosan-collagen scaffolds can regulate the biologicalactivities of adipose mesenchymal stem cells for tissueengineering. J Regen Med Tissue Eng. 2013; 2:12. http://dx.doi.org/10.7243/2050-1218-2-12.

****