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Clinical research on the bone graft and the use of plasma-rich fibrin: a concise systematic review

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Abstract

Introduction: Bone augmentation techniques have been increasingly indicated to recreate adequate bone height and volume for dental implant sites. Maxillary sinus augmentation can be performed with or without graft biomaterials. In this sense, fibrin-rich plasma (PRF) stands out, which is a three-dimensional (3-D) autogenous biomaterial. **Objective:** It was carried out a systematic review of the literature on the main considerations and clinical findings of bone grafting and fibrin-rich plasma in oral and maxillofacial surgery. **Methods:** The present study followed a systematic review model, following the rules of systematic review – PRISMA. The search strategy was performed in the PubMed, Cochrane Library, Web of Science and Scopus, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** The total of 256 articles were found. A total of 64 articles were fully evaluated and 28 were included in this study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 134 studies that were excluded with a high risk of bias (studies with small sample size). Also, 38 studies were excluded because they did not meet the GRADE. The application of autologous platelet-rich plasma provides benefits in promoting soft tissue healing and bone regeneration in different surgical procedures, as well as being favorable for bone formation processes for dental implants, especially when combined with xenografts. In addition, it is an autologous, low-cost biomaterial that does not require the administration of additives. However, further studies with larger sample sizes and longer follow-up times are needed to provide more substantial evidence of the efficacy of platelet-rich plasma in promoting soft and hard tissue healing.

Keywords: Bone augmentation. Bone graft. PRF. Biomaterial. Dental implant.

Introduction

The maxillary sinus is the largest of the paranasal sinuses and its function is to contribute to the resonance of phonation, conditioning the air we breathe and aiding in the production of mucus in the nasal cavity [1]. It also acts in the equalization of barometric pressures in the nasal cavity, which is covered by a membrane called Schneider's membrane [1].

In this context, bone augmentation techniques have been increasingly indicated to recreate adequate bone height and volume for dental implant sites [2,3]. This is particularly applicable in the severely atrophic posterior maxilla, where sinus perforation (ruptured Schneiderian membrane) is a very common complication and sinus floor elevation or lifting is often considered a standard procedure. Maxillary sinus augmentation can be performed with or without graft biomaterials [3].

Furthermore, cytokines and growth factors have been used to stimulate angiogenesis, improve bone formation, as well as improve the healing and recovery period, either as the sole filling material or in combination with bone substitute materials [3]. Within it is the family of autologous blood extracts, the so-called platelet concentrates, which are simply the "product" resulting from the simple centrifugation of

whole blood samples collected from the patient, immediately before surgery. Plasma-Rich Fibrin (PRF), a subfamily of platelet concentrates, is a three-dimensional (3-D) autogenous biomaterial obtained, not including anticoagulants, bovine thrombin, additives, or any gelling agents during the centrifugation process. Today, it is safe to say that, in implant dentistry and oral and maxillofacial surgery, PRF are receiving attention, essentially due to their simplicity, speed, ease of use/malleability, and cost-effectiveness. Whether used as the sole "bioactive" filler/additive material or combined with bone substitutes, revolutionary second-generation PRF have often been associated with promising clinical outcomes [4].

Also, when the loss of a dental element in the posterior region of the maxilla occurs, there is natural resorption of the alveolar process and at the same time, pneumatization of the maxillary sinus will occur [5,6]. It will increase its volume towards the place where the roots existed and this will often make it difficult or impossible to restore implants in place [7]. For this reason, the maxillary sinus floor elevation procedure should be performed, or short implants when possible. When graft procedures are needed, our focus is often on the type of biomaterial to be used and the success and predictability of our results do not depend only on the biomaterial [7].

It is also necessary to consider the type of defect to be treated, and its morphology. The morphology will have an impact mainly because the defects have different vascularization capacity, different osteogenic cell recruitment capacity, have different natural stabilization capacities of grafts, therefore, we must consider the characteristics of the biomaterial that we must employ, but also the characteristics of the bed and the bone defect that we intend to treat [8]. In addition, several surgical techniques can be used to reconstruct the atrophic alveolar ridge, techniques alone or associated with autogenous, allogeneic, xenogeneic, and alloplastic biomaterials. The autogenous bone graft is the only one capable of presenting three important biological properties (osteogenesis, osteoinduction, and osteoconduction) guaranteeing a self-regenerative potential [7,9].

In this sense, PRF is an autologous platelet concentrate consisting of circulating cytokines, platelets, leukocytes, and stem cells. It is effective in bone regeneration and is primarily used for oral and maxillofacial bone [10].

Therefore, the present study aimed to carry out a systematic review of the literature on the main considerations and clinical findings of bone grafting and plasma-rich fibrin in oral and maxillofacial surgery.

Methods

Study Design

The present study followed a systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic review and meta-analysis, access available in: http://www.prisma-statement.org/).

Data Sources

The search strategy was performed in the PubMed, Cochrane Library, Web of Science and Scopus, and Google Scholar databases. The present study was carried out from February to May of 2022.

Descriptors (MeSH Terms) And Search Strategy

The main descriptors (MeSH Terms) used were "*Bone augmentation. Bone graft. PRF. Biomaterial. Dental implant*". The rules of the word PICOS (Patient; Intervention; Control; Outcomes; Study Design) were followed.

Selection Process, Risk of Bias and Quality of Studies

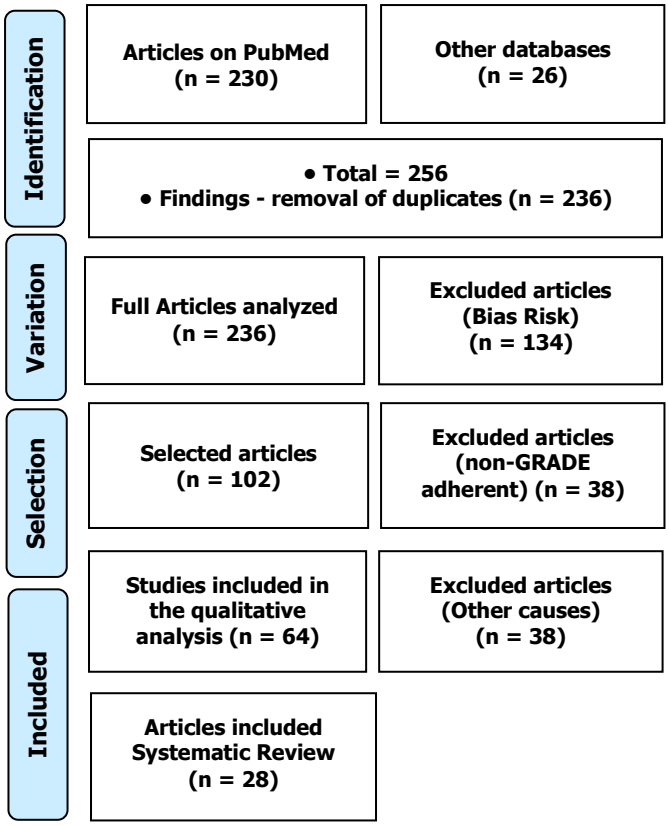
Two independent reviewers performed research and study selection. Data extraction was performed by reviewer 1 and fully reviewed by reviewer 2. A third investigator decided some conflicting points and made the final decision to choose the articles. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument.

Results and Discussion

Article Series and Eligibility

The total of 256 articles were found. Initially, the duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed. A total of 64 articles were fully evaluated and 28 were included in this study (**Figure 1**). Considering the Cochrane tool for risk of bias, the overall assessment resulted in 134 studies that were excluded with a high risk of bias (studies with a small sample size). Also, 38 studies were excluded because they did not meet the GRADE.

Figure 1. Flowchart showing the article selection process.



In the scenario of maxillary sinus surgery, the lack of bone in the alveolar crests has been a major problem in the functional aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic tooth extractions, congenital tooth absence, maxillary and mandibular pathologies, in addition to infections due to emotional and the possibility of deformity and also the economic impact they cause on the National Health System (NHS) [1-3].

Furthermore, bone loss can also occur due to periodontal disease, traumatic surgeries, or even for physiological reasons due to lack of adequate or inadequate prosthetic loading [7]. Trauma to the face region can affect both soft and hard tissues, so these injuries can affect the victim's quality of life and health [7-9].

In this context, PRF as an autologous biomaterial was developed in France by Choukroun et al. (2006) [8] for specific use in oral and maxillofacial surgery. This biomaterial presents the majority of leukocytes, platelets, and growth factors, forming a fibrin matrix with a three-dimensional architecture. It is the second generation of platelet concentrate with a high potential for wound repair [11,12]. Also, PRF is based on the protection of growth factors from proteolysis that can maintain their activity for a longer period and stimulate bone regeneration more efficiently [13-19]. The most critical phase of the sinus membrane elevation procedure after osteotomy of the lateral wall of the maxillary sinus is its detachment [20-24].

In this regard, the development of optimized implant surfaces is the subject of a great deal of research to accelerate the osseointegration process, leading to a reduction in the waiting time before loading, in addition to making the immediate loading of the implant safer [25-28]. It was documented for the first time that the combination of biomaterial and PRF significantly improved bone regeneration in the peri-implant zone. Implant placement with the simultaneous use of Platelet-Rich Plasma (PRP) creates a good relationship between hard tissue and soft tissue, in addition to the advantage of the psychological relationship with the patient [1].

In this context, the most used xenograft in guided bone regeneration procedures is deproteinized bovine bone mineral, commercially known as Bio-Oss®, it is the most researched product in regenerative dentistry worldwide. It is a bone of bovine origin processed to produce natural bone minerals without organic elements. After thermal and chemical treatments, the inorganic phase of bovine bone consists mainly of hydroxyapatite (HA) which retains the porous architecture. The excellent osteoconductive properties of Bio-Oss® lead to predictable and efficient bone regeneration, Bio-Oss® particles become an integral part of the newly formed bone structure and retain their volume over the long term. Due to its great resemblance to human bone, Bio Oss® is incorporated into the natural process of modeling and remodeling. The highly porous structure of Bio Oss® offers plenty of space for the formation of blood vessels (angiogenesis) and the deposit of neoformed bone. The microstructure of the surface Bio Oss® helps the excellent growth of osteoblasts which are responsible for bone formation [24].

Based on this, one study reported results on the combined use of Bio-Oss® and PRF. Thus, the first study investigated clinically and histologically the potential of PRF as a grafting material in pre-implantation reconstructive surgery of severe maxillary atrophy after sinus lift procedures at 106-120-180 days, to determine whether the use of PRF is capable of accelerating the bone regeneration process, which is essential to promote implant stability. This study also includes a control group, in which only deproteinized bovine bone (Bio-Oss®) was used as the reconstructive material. As a result, the use of PRF optimized bone formation [22].

Thus, for the success of dental implant practice, osseointegration is essential. However, it is a complex process with many factors interfering with the formation and maintenance of bone tissue around the implant,

such as topography and surface roughness, biocompatibility, and loading conditions. In addition, a healthy, compatible host bone layer that allows primary stability is required [25].

In this sense, the bioactivation of the dental implant surface with PRF has been described and discussed by the scientific community as a surface treatment for the stimulation and acceleration of the osseointegration process, as well as to achieve greater primary stability in the implant [28].

Conclusion

By the objective of the present study, it was concluded that the application of autologous plasma-rich fibrin provides benefits in promoting soft tissue healing and bone regeneration in different surgical procedures, as well as being favorable for bone formation processes for dental implants, especially when combined with xenografts. In addition, it is an autologous, low-cost biomaterial that does not require the administration of additives. However, further studies with larger sample sizes and longer follow-up times are needed to provide more substantial evidence of the efficacy of plasma-rich fibrin in promoting soft and hard tissue healing.

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Conflict of interest
The authors declare no conflict of interest.

Similarity check
It was applied by Ithenticate@.

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