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Review article

APPLICATION OF PLATELET-RICH PLASMA (PRP) FOR REGENERATION OF VERTICAL BONE DEFECTS

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ABSTRACT

In recent years, there has been a sharp increase in the number of chronic periodontal diseases. The problem of their widespread distribution and the need for their treatment is one of the priorities of modern dentistry. Periodontal bone defects are the result of chronic periodontitis if timely measures are not taken to stop the inflammatory process. The goal of periodontal treatment is to remove all deposits of supra- and subgingival dental plaque and calculus (containing periodontopathogens) and their plaque-retentive factors and to promote complete regeneration of the tooth-supporting structures lost up to that point. Until now, autogenous, platelet-rich plasma has been widely used in various fields of medicine. Because of the equivalent results obtained and the lower cost, in dentistry, autogenous platelet-rich plasma is increasingly the preferred material over others that have proven to be reliable over time. Summarizing the results of various authors who used autogenous platelet-rich plasma alone or in combination with other materials for the purpose of regeneration of vertical bone defects, it is clear that PRP significantly accelerates the restorative and regenerative processes in the periodontium.

Keywords: periodontology, platelet-rich plasma, vertical bone defects, periodontitis, periodontal treatment,

INTRODUCTION

The purpose of our study is to make a systematic analysis of the scientific activity related to the influence of autogenous, platelet-rich plasma in the regeneration of vertical bone defects resulting from past periodontitis.

Today, the main goal of periodontal treatment consists in the elimination of periodontopathogenic microorganisms and regeneration of the lost structures of the periodontium. Vertical bone defects are an inevitable consequence of periodontitis if timely measures are not taken to stop the inflammatory process.

Over the years, various surgical techniques and materials have been established for the purposes of regenerative therapy. Nowadays, the focus is on the development of improved biomaterials to provide even better results. Various barrier membranes, bone-restorative materials, biologically active materials and combinations thereof are used.

Autogenous platelet-rich plasma (PRP) is a platelet-rich substance obtained after specific processing of peripheral blood. Peripheral blood consists of plasma and formed elements - erythrocytes, platelets and leukocytes. Platelets contain three types of granules – á-granules, dense granules and lysosomes. Upon platelet activation and degranulation, á-granules release multiple growth factors. Growth factors have been found to promote cell proliferation, migration and metabolic activity, affect chemotaxis and the production of extracellular matrix proteins.

MATERIALS AND METHODS

Systematical research of articles related to guided tissue regeneration, periodontal regeneration, platelet-rich plasma therapy, and vertical bone defects was performed using the aforementioned keywords in the English language throughout publications published in PubMed and Google Scholar from 2002 to 2022.

RESULTS AND DISCUSSION

A rapid incline in the number of chronic periodontal diseases has been observed over recent years based on various epidemiological data. The problem with their wide distribution and the necessity of treatment has become one of the top priorities of modern dental medicine.

Data from World Health Organization shows that from 80 to 100% of the world's population suffers from one or another form of periodontitis, which leads to significant changes in the tooth-holding apparatus (periodontium), has a negative effect on the digestive process, has a negative effect on the psycho-emotional aspect of the patient and, therefore, worsens the quality of his life, which determines the social significance of this problem [1, 2].

The appearance and severity of chronic periodontitis is determined by the balance between the bacterial microflora and the resistance of the macro-organism to it. The subgingival dental biofilm elicits an inflammatory and immune response from the host, ultimately leading to irreversible destruction of the periodontium (alveolar bone and periodontal ligament). However, various factors, both local and systemic, have been found to contribute to the progression of periodontal diseases [3]. The clinical symptoms of chronic periodontitis reflect the predominance of destructive changes and dysfunction over restorative processes of local and systemic homeostasis [4].

From a clinical point of view, periodontitis presents with supra- and subgingival plaque and calculus deposits, changes in gingival color, consistency, and elasticity, gingival edema, bleeding on probing, loss of clinical attachment level, and resorption of alveolar bone. [4].

Periodontal bone defects are the result of chronic periodontitis if measures are not taken at the proper time to stop the inflammatory process. There are two types of bone resorption - vertical (angular) and horizontal [5, 6]. According to Goldman and Cohen's classification [7], there are two types of bone defects: supraosseous (suprabony) and infraosseous (infrabony) defects. Supraosseous are the defects whose base is located coronal to the residual alveolar ridge. Infraosseous are the defects whose base is located apical to the residual alveolar ridge. Infraosseous defects are divided into infraosseous defects and craters. Infraosseous are those that affect the àproximal surface of only one tooth, while craters affect the àproximal surfaces of two adjacent teeth. According to their morphology, infraaxial defects are further divided into – single-walled, double-walled, three-walled and cuvette-shaped. In the single-walled bone defect, the vestibular and oral cortical bones are eliminated. In the double-walled bone defect, either the vestibular or the oral cortical bone is eliminated. In the three-sided bone defect, the vestibular and oral cortical bones are preserved. In the cuvette-shaped bone defect, there is a circular resorption of the bone around the tooth root [8,9].

The goal of periodontal treatment is to remove all deposits of supra- and subgingival dental plaque and calculus (containing periodontopathogens) and their plaque-retentive factors and to promote complete regeneration of the tooth-supporting structures lost up to that point - alveolar bone, cementum and periodontal ligament [10,11].

In this regard, the scientific search for new methods, materials and combinations between them, increasing the therapeutic effect, combining it with maximum safety and high biological activity on the part of the organism, remains an important part of modern dental medicine [10, 12, 13].

Until now, autogenous, platelet-rich plasma has been widely used in various fields of medicine – surgery, dentistry, traumatology and orthopedics, sports medicine, dermatology, etc. [14, 15, 16, 17, 18]. Due to the obtained equivalent results and the lower price - in the various specialties of dental medicine (oral surgery, periodontology, dental implantology), the use of autogenous platelet-rich plasma is increasingly becoming the preferred method [17, 19, 20, 21], compared to others that have proven themselves over time to be reliable [22, 23, 24].

Summarizing the results of various authors who used autogenous platelet-rich plasma alone or in combination with other materials for the purpose of regeneration of vertical bone defects, it is clear that PRP significantly accelerates the restorative and regenerative processes in the periodontium [19, 25, 26, 27].

In 2002 Camargo et al. [28] published the results of their clinical study and concluded that guided tissue regeneration using PRP and bovine porous bone mineral (BPBM) provided an additional regenerative effect in vertical bone defects of patients with severe periodontitis.

In 2005 Okuda et al. [29] conducted a comparative study in the treatment of vertical bone defects, which found that the method using hydroxylapatite in combination with PRP leads to significantly better clinical results compared to the method of using hydroxylapatite with saline.

In 2007, Yassibag-Berkman et al. [30] compared clinically and radiologically the results after the treatment of 30 pieces of two- and three-walled vertical bone defects. Patients were divided into three groups, with the first group using bone repair material alone (beta tricalcium phosphate, beta-TCP), the second group using beta-TCP in combination with PRP, and the third group using beta-TCP with PRP and a barrier membrane. At 12 months postoperatively, they evaluated the results and found that there were no statistically significant differences in clinical and radiological measurements between the three groups.

In 2008, Dxri et al. [31] aimed to clinically evaluate the effect of PRP on the healing process of deep intraosseous defects treated with beta tricalcium phosphate (beta-TCP) and non-bioresorbable expanded polytetrafluoroethylene membrane. The results are clinically tested. At the end of the first year after surgery, both therapies (with and without PRP) appeared to result in a significant reduction in pocket depth and an increase in clinical attachment level, but no statistically significant differences were found in any of the clinical parameters between the two groups, i.e. there were no additional clinical benefits of PRP.

Roselló-Camps et al. in 2015 [32] published a systematic review and meta-analysis that aimed to evaluate the impact of platelet-rich plasma (PRP) on the regeneration of periodontal intraosseous defects by comparative evaluation of clinical and radiological outcomes. The main question they wanted to answer was whether PRP has a higher or similar effectiveness regarding the regeneration of periodontal vertical defects compared to other

conventional methods of periodontal regeneration (e.g., bone repair materials, barrier membranes). Ultimately, it appeared that due to the large heterogeneity among the studies, it was not possible to draw a definitive conclusion. However, it has been found that PRP may offer some beneficial effects on clinical and radiographic outcomes for regeneration of vertical bone defects.

In 2015, Thakkalapati et al. [33] concluded that in the treatment of single-wall intraosseous defects with the help of PRP and Demineralized Bone Matrix, results with a significant improvement in clinical and radiological parameters are obtained.

Hou et al. published in 2016 [34] systematic review and meta-analysis, as the existing studies to date investigating PRP in the treatment of intraosseous defects have yielded mixed results. They aimed to evaluate the efficacy of PRP by comparing the clinical parameters - clinical attachment level (CAL) and pocket depth (PD) for patients who received PRP as an adjunct to periodontal vertical defect therapy with those of patients who did not receive PRP. In conclusion, this review suggests that PRP may be useful as an adjunct to transplanted materials for the treatment of periodontal vertical defects, except in cases involving the use of Guided Tissue Regeneration (GTR).

In 2018 Jalaluddin et al. [35] performed a prospective, randomized, controlled trial comparing the regenerative potential of PRP and bone repair material in vertical bone defects. The study includes 20 pcs of vertical defects, which are divided into two groups. In the first group, PRP alone is used, and in the other, a bone reparative material. The results were evaluated clinically at the third and sixth months and radiologically (intraoral periapical radiography) at the sixth month after the surgical intervention. In conclusion, both groups were found to show promising results in improving periodontal regeneration. However, the results with the bone repair material were relatively better, although not statistically significant compared to PRP alone.

In the same year, Hu et al. [36] performed a meta-analysis aimed at evaluating the impact of PRP in combination with demineralized freeze-dried bone allograft (DFDBA) in the treatment of vertical bone defects. The authors concluded that PRP in combination with DFDBA was superior to PRP or DFDBA alone in some of the parameters studied.

In 2022, Mahmoud et al. [37] published a study whose aim was to evaluate the effectiveness of the application of hydroxyapatite alone and in combination with PRP in the regeneration of periodontal vertical defects. The study included twenty-four patients with advanced chronic periodontitis. At the end of the 3rd and 6th months, it was established that satisfactory clinical and radiological results were found in both groups of patients. In conclusion, the authors found, however, that no statistically significant difference was found when comparing the results between the two groups.

In 2022 a study investigating the biological effects and molecular mechanisms of PRP in periodontal regenerative therapy was published. The authors concluded that autogenous platelet-rich plasma demonstrated a high biological effect on the regenerative processes of periodontal tissues. Its mechanisms of action were related to promoting the growth, proliferation, differentiation and migration of osteoblasts and cells from the periodontium to the area to be regenerated [38].

In 2022, Dxri et al. [39] set out to investigate histologically Retrieved expanded polytetrafluoroethylene membranes (ePTFE membranes) used together with PRP and various bone reparative materials in guided tissue regeneration of periodontal vertical bone defects. Regarding the involvement of PRP in the study, the authors concluded that PRP had no significant effect on the quality of membrane integration when combined with NBM but significantly improved the quality of integration when combined with beta-TCP.

From the reviewed literature, it is clear that autogenous platelet-rich plasma (PRP) is a material that definitely contributes to better results in regenerative therapy of vertical bone defects. A large part of the authors relies on the qualities of PRP, but not as an independently applied material, but as a supplementary material to the standardized - bone restorative materials and barrier membranes.

CONCLUSION

Based on the analyzed studies we can conclude that one of the main advantages of this autogenous material is that the efficiency/price ratio is extremely high. The protocol for making PRP, however, is more labor-intensive, more time-consuming and is associated with possible inaccuracies and errors in the method of obtaining.

The presented study shows that there is a lot of research at present related to the application of autogenous, platelet-rich plasma in periodontology and, more specifically, for the treatment of vertical bone defects that are the result of past periodontitis. However, there is still no consensus regarding the effects of PRP in the regenerative therapy of periodontal vertical bone defects.

Abbreviations:

PRP - Platelet rich plasma
BPBM - Bovine porous bone mineral
beta-TCP - Beta tricalcium phosphate
CAL - Clinical attachment level
PD - Pocket depth
GTR - Guided Tissue Regeneration
DFDBA - Demineralized freeze-dried bone allograft
ePTFE membranes - Expanded polytetrafluoroethylene membranes

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