



Comparison of Bone Morphogenic Proteins' and Platelet Rich Fibrins' Effectiveness in Socket Preservation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The dentist faces a difficult challenge in preserving the quantity and quality of gum and bone tissues. Furthermore, the processes adopted should meet these objectives while posing no substantial future issues. In current dental and maxillofacial surgery, a variety of materials as

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Morphogenic Protein of Bone (BMP) and Platelet Rich Fibrins (PRF) are employed to repair and reconstruct bone tissue. The purpose of this review was to compare the efficiency of both BMP's and PRF's in Socket preservation. Reviewing the literature was conducted by using the following search strategies: Bone Morphogenic Proteins, Platelet Rich Fibrins, socket preservation approach, comparison of BMPs and PRFs, Bone Morphogenic Proteins and effectiveness in socket preservation and Platelet Rich Fibrins' effectiveness in socket preservation. In conclusion, BMPs have been studied more completely than PRFs, and they have higher impacts on hard tissue regeneration and repair, according to the research. The fact that PRFs increase soft tissue healing shows how promising they are. Especially when we consider that soft tissue healing is more important than socket care in implant dentistry.

Keywords: *Bone morphogenic proteins; platelet rich fibrins; socket preservation; dental biomaterial; dental implant.*

1. INTRODUCTION

Implant treatment success is now judged not just by implant longevity, but also by long-term functional and esthetic success [1]. Aside from the implant's three - dimensional placement, the quantity of bone available at the implant site can also influence the cosmetic result. Following tooth extraction, the alveolar ridge experiences resorptive alterations, which has been extensively reported. As a result of these alterations, the ridge's proportions are reduced [2]. Teeth extractions are indicated for a variety of reasons. It is sometimes essential due to tooth discomfort, infection, bone loss, or fracture. Disease and/or infection destroy the bone that keeps the tooth in place (the socket), leading to jaw deformity after the tooth is pulled [3]. The literature shows morphologic and dimensional alterations in the alveolar ridge following tooth extraction. In a clinical investigation, it was shown that within the first 12 months after tooth extraction, the average horizontal volume loss was 5–7mm. According to the authors, these values resulted in a loss of nearly 50% of the original alveolar bone width [4]. Socket preservation is a surgical operation whose purpose is to restrict the physiological resorption of the alveolar ridge that takes place after a dental extraction, to sooner or later have enough bone for implant placement [5]. When performed following an atraumatic extraction with the assistance of biomaterials and membranes, socket preservation is an effective therapy for preventing bone resorption. It's also vital to remember that local and systemic individual factors have a role [6].

Platelet-rich fibrin (PRF) is a kind of platelet concentrate that is utilized in a variety of dental procedures. However, whether PRF is beneficial in preserving the alveolar ridge is debatable [7].

BMPs (bone morphogenetic proteins) are a group of developmental factors that includes cytokines and metabologens. BMPs are a set of crucial morphogenetic signals that orchestrate tissue architecture throughout the body. They were first recognized for their capacity to stimulate the creation of bone and cartilage. The diversity of functions for dysregulated BMP signaling in diseased diseases emphasizes the importance of BMP signals in physiology [8]. To this day, it's unclear whether method of socket preservation is the most reliable and there has been no study done before to compare effectiveness of Bone Morphogenic Proteins and Platelet Rich Fibrins in socket preservation. The aim of this review was to Compare the effectiveness of both BMP's and PRF's in Socket Preservation. A thorough review of the literature.

2. MATERIALS AND METHODS

A thorough review of the literature was conducted to Compare the effectiveness of both BMP's and PRF's in Socket Preservation. Articles published over the previous ten years, conducted in at least one of the following regions: North America, Europe, or MENA, and indexed on Wiley Online Library, PUBMED, BiblioMed, or Google Scholar were considered. Using the following search strategies: Bone Morphogenic Proteins, Platelet Rich Fibrins, Socket Preservation Approach, Comparison of Bone Morphogenic Proteins' and Platelet Rich Fibrins, Bone Morphogenic Proteins and Effectiveness in Socket Preservation and Platelet Rich Fibrins' Effectiveness in Socket Preservation. The studies were chosen based on the title, abstracts, and methodology found in electronic searches, as well as complete texts. Articles that were not written in English were immediately disqualified. Mendeley, a reference

management application, was used to remove the duplicated article. Two reviewers verified and assessed the complete content of the prospective publications by studying the abstract and title of each connected paper. Two reviewers extracted the result and study characteristics individually and anonymously using the updated data extraction form.

3. RESULTS AND DISCUSSION

3.1 Socket Preservation

Disease and/or infection can affect the bone that supports the tooth in place (the socket), leading to jaw distortion after the tooth is removed. Furthermore, when teeth are taken, the surrounding bone and gums can quickly shrink and recede, resulting in unattractive deformities and the collapse of the lips and cheeks. Endodontic illness, periodontitis, face trauma, and forceful extraction operations can all contribute to the loss of alveolar bone. When it comes to restorative dentistry, whether it's dental implants, bridges, or dentures, these jaw deformities can cause severe issues [9]. A treatment known as socket preservation can prevent and cure jaw abnormalities caused by tooth removal. Socket preservation can significantly improve the aesthetics of the smile and boost the likelihood of long-term success with dental implants [2].

Biological mechanisms of bone grafting are based on:

- I. Osteoconduction
- II. Osteoinduction
- III. Osteogenesis
- IV. Osteopromotion

When the bone graft material acts as a scaffold for new bone development that is sustained by the original bone, this is called **osteoconduction** [10]. **Osteoinduction** is the process of stimulating osteoprogenitor cells to develop into osteoblasts, which subsequently start the production of new bone. Bone morphogenetic proteins are the most well-studied form of osteoinductive cell mediator (BMPs) [11]. **Osteogenesis** happens when important osteoblasts derived from the bone graft material help to build new bone growth in addition to the two other methods [12].

Osteopromotion is the process of enhancing osteoinduction without having osteoinductive qualities. Enamel matrix derivative, for example,

has been demonstrated to improve the osteoinductive action of demineralized freeze-dried bone allograft (DFDBA), but it does not induce de novo bone development on its own [13].

Socket preservation is a necessary operation, with the most significant and fundamental goal being to avoid bone loss after tooth extraction. Preservation, as the term implies, is the preservation of the socket, which is the height and width of the gap left when a tooth is extracted. To retain bone height, width, and density, a graft material or scaffold is immediately placed into the socket of a removed tooth [3].

3.2 Materials for Bone Tissue Substitutions

In current dental and maxillofacial surgery, a variety of materials are employed to replace and rebuild bone tissue. Autogenic (donor is the patient), allogenic (donor is another person), xenogenic (donor is an animal) and synthetic (donor is a synthetic substance) are the four types of osteoplastic materials (on the basis of calcium salts). The development of xenogenic and synthetic biomaterials with osteoconductive and osteoinductive qualities has allowed for a reduction in the usage of auto- and allotransplantation procedures, which have a number of drawbacks [14]. Due to its endless supply, ease of storage, and sterility, the desire for an ideal nonautogenous bone grafting material is growing [15].

Synthetic bone replacements (alloplasts) are osteoconductive - that is, they provide a scaffold for bone deposition—as opposed to osteoinductive materials such as autografts, which may include growth factors necessary for osteogenesis. Commercially available synthetic bone replacements have been made of hydroxyapatite, tricalcium phosphate, calcium sulfate, and combinations of these minerals, and fabrication techniques, crystal configurations, pore dimensions, mechanical properties, and resorption rates vary [16–18].

There are a variety of bone augmentation techniques presented by Byrne [19] using one or more of the following:

Bioactive glass with calcium sulfate (BG/CS), freeze dried bone allograft (FDBA), magnesium-enriched hydroxyapatite, organic cancellous

porcine bone xenograft (CPB), calcium sulfate (CS) are some of the **bone fillers**.

Collagen sponges: bioabsorbable polylactide-polyglycolide acid sponge (BAS), absorbable collagen sponge.

BMPs: human bone morphogenic protein-2 growth factor recombinant.

Membranes: bioabsorbable membrane made from glycolide and lactide polymers (BAM) and nonabsorbable expanded tetrafluoroethylene membrane (NAM).

Synthetic resorbable materials were designed to be a low-cost alternative for genuine bone. Ceramics such as tricalcium phosphate, bioglass, and hydroxyapatite and their compositions with collagen, sulphated glycosaminoglycans such as keratan and chondroitin sulphate, as well as sulphate and calcium phosphate, are examples of synthetic graft materials. Porous nanostructured calcium phosphate ceramics, bone cements, biohybrids, and biocomposite materials have all been developed [20,21].

Socket preservation is important to achieve an optimal aesthetic appearance for implant-supported restorations. Inconclusive evidence suggests that socket-preserving interventions can help reduce bone dimensional changes after tooth extraction, but do not prevent ridge resorption. However, preserving the socket helps preserve the alveolar structure. Preserving the teeth can significantly reduce the loss of alveolar ridge width and height after extraction [9].

3.3 Bone Morphogenic Proteins

Because bone heals through the production of new bone rather than scar tissue, bone regeneration may be thought of as a recapitulation of embryonic bone growth [22]. This bone repair or regeneration process requires a complex network of chemicals, including bone morphogenetic proteins (BMPs) [23]. BMPs, or Bone Morphogenic Proteins, are members of a broader protein superfamily that have been extensively researched for their potential role in bone healing improvement [24]. There are around 20 different kinds of BMPs, but only a fraction of them can promote de novo bone growth. Many studies have demonstrated that BMPs can trigger mesenchymal stem cell and stem cell differentiation into osteogenic cells capable of generating bone [24]. BMPs are the

most promising and extensively researched group of growth factors involved in bone healing improvement [25,26]. Although the method by which BMPs stimulate osteoblastic differentiation is unknown, it is known that these growth factors play a critical role in osteoblast differentiation control [27].

3.4 Platelet Rich Fibrins

Platelet-rich fibrin (PRF) has recently been suggested acceptable for oral and maxillofacial bone repair [28,29]. It is referred to as the second generation of platelet concentrates since it is produced utilizing a simpler technique that comprises centrifugation of autogenous peripheral blood without the use of biological agents [7]. PRF is a dense fibrin scaffold that contains cytokines, platelets, leukocytes, and circulating stem cells and is made up of a fibrin matrix polymerized in a four-molecule structure [30,31].

Platelet concentrates were divided into four groups by Dohan Ehrenfest et al. [30] based on their leucocyte and fibrin content: pure platelet-rich plasma (P-PRP), leucocyte- and platelet-rich plasma (L-PRP), pure platelet-rich fibrin (P-PRF), and leucocyte- and platelet-rich fibrin (L-PRF) [32].

In the case of bone regeneration, PRF might be a viable alternative to osteogenic media [33]. PRF has been demonstrated to improve stem cell proliferation, differentiation, migration, and mineralization during bone formation in most investigations, however the effects vary by cell type. As a result, the cell type chosen has an impact on osteogenesis [28]. PRF may be employed as an osteogenic medium for cultivating GSPCs, PDLSCs, osteoblasts, PDL fibroblasts, and DFSCs, according to experiments, and the improved osteogenesis impact may favor the osteoblasts [34].

Choukroun et al., the first to describe PRF, discovered that augmentation of the sinus floor with FDBA and PRF decreases healing time in people prior to implantation. They compared an FDBA+PRF-grafted group that was harvested after four months to an FDBA-only grafted group that was harvested after eight months. Because the two groups (FDBA alone and FDBA+PRF) have similar histological characteristics, sinus floor augmentation surgery with a shorter healing period before implantation (4 months instead of 8 months) is a viable option [31].

Table 1. Articles comparing BMPs and PRFs

Research Article	Findings
<ul style="list-style-type: none"> Medikeri RS et al [36]. 	<ul style="list-style-type: none"> rhBMP-2 showed statistically significant results only with respect to radiographic bone fill when compared with platelet-rich fibrin at 6 months.
<ul style="list-style-type: none"> Vandana LK et al [38]. 	<ul style="list-style-type: none"> Pocket Depth Reduction (PPD) <ul style="list-style-type: none"> greater in PRF-treated sites compared to control sites. not significant between rhBMP-2-treated and control sites. greater in PRF-treated sites as compared to rhBMP-2 Clinical Attachment Level (CAL) <ul style="list-style-type: none"> greater in the PRF-treated sites when compared to control sites. not significant between rhBMP-2-treated sites and control sites. Not significant in rhBMP-2-treated sites compared to PRF-treated sites Intrabony Defect <ul style="list-style-type: none"> original defects resolved were significantly greater in rhBMP-2-treated group compared to PRF-treated group. They, rhBMP is a superior graft material compared to PRF in terms of hard tissue regeneration and CAL improvement However, the advantage of PRF which has improved soft tissue healing. for sinus augmentation in rabbits, Compared: <ul style="list-style-type: none"> Type I absorbable collagen sponge (ACS) impregnated with recombinant human bone morphogenetic protein (rhBMP)-2 (rhBMP-2+ACS), rhBMP-2 coated tricalcium phosphate (rhBMP-2+TCP), PRF mixed tricalcium phosphate (PRF+TCP). On Week 2: <ul style="list-style-type: none"> rhBMP-2+ACS group and PRF+TCP group showed more rigid and well-osteointegrated graft material. rhBMP-2+ACS group showed significantly faster and more extensive bone formation areas than the PRF+TCP group. After week 4, <ul style="list-style-type: none"> There was no apparent differentiation of rigidity among the groups.
<ul style="list-style-type: none"> Chul-Hun Kim et al [39]. 	

Research Article	Findings
<ul style="list-style-type: none"> Alhussaini [40]. 	<ul style="list-style-type: none"> rhBMP-2+ACS and PRF+TCP had improved early bone formation properties compared to rhBMP-2+TCP. These results indicate that simply impregnating ACS with rhBMP-2 has significant bone regeneration capacity comparable with that of PRF+TCP. <ul style="list-style-type: none"> Goal to determine the bioactive material with the best effect on implant stability. The implant stability of the rhBMP-2 group was significantly better than those of the PRF and control groups 6 weeks after implant insertion. After 12 weeks, the effect of rhBMP-2 on implant stability was highly significant and better than that of the other groups. Concluded that Dental implants coated with BMP have a better effect on stability than those with PRF alone and those without PRF or BMP.

3.5 Comparing BMPs' and PRFs' Socket Preservation Efficacy

PRF and rhBMP-2 are now the most commonly investigated and utilized materials in implant dentistry for bone defect regeneration [35]. Despite the fact that they were primarily concerned with the treatment of intrabony abnormalities in periodontitis patients. In a Systematic Review, Medikeri RS et al found that rhBMP2 demonstrated statistically significant outcomes only when compared to platelet-rich fibrin at 6 months in terms of radiographic bone fill [36]. They also stated that due to the limited number of human investigations, there is insufficient data to determine the efficacy of rhBMP-2 in the treatment of intrabony deficiencies in periodontal disease. Due to the scarcity of evidence, the generalizability of rhBMP-2 is still unknown, necessitating additional research for better analysis and conclusion derivation [37].

A randomized, controlled clinical and radiographic investigation was undertaken by Vandana LK et al. Split mouth controlled clinical trial was the study's design. rhBMP2 and autologous platelet rich fibrin are compared. A randomized, double-masked trial with 32 participants, a 6-month follow-up, and a randomized, double-masked study There were no dropouts among the 32 individuals who were

included in the research. The individuals in the research had no negative responses to the medication. In all of the study's locations, postsurgical recovery was uneventful. They, rhBMP is a superior graft material compared to PRF in terms of hard tissue regeneration and CAL improvement. However, the advantage of PRF which has improved soft tissue healing. [38].

In rabbits, Chul-Hun Kim et al. evaluated sinus augmentation using Type I absorbable collagen sponge (ACS) impregnated with recombinant human bone morphogenetic protein (rhBMP)-2 (rhBMP-2+ACS), rhBMP-2 coated tricalcium phosphate (rhBMP-2+TCP), and PRF mixed tricalcium phosphate (PRF+TCP). TCP [Ca₃(PO₄)₂], a synthetic bone-promoting biomaterial, has been extensively applied and investigated as a biodegradable bone replacement for repairing various shapes and sizes of bone defects caused by trauma, tumor resection, or skeletal abnormalities, according to Chul-Hun Kim et al. TCP [Ca₃(PO₄)₂], a synthetic bone-promoting biomaterial, has been extensively applied and investigated as a biodegradable bone replacement for repairing various shapes TCP is a highly osteoconductive but not osteoinductive substance. TCP was given an osteoconductive property in this work by covering it with rhBMP-2 (Group B) and combining it with PRF (Group C)

At the conclusion of their research, Chul-Hun Kim et al. discovered that Group A (rhBMP-2+ACS), Group B (rhBMP-2+TCP), and Group C (PRF+TCP) were all well suited in critical bone defects. They also discovered that the (rhBMP-2+ACS) and (PRF+TCP) groups had more stiff and well-osteointegrated graft material at Week 2. After four weeks, however, there was no discernible difference in stiffness across the groups. Finally, they discovered that when compared to rhBMP-2+TCP, rhBMP-2+ACS (Group A) and PRF+TCP (Group C) exhibited better early bone formation qualities (Group B). Furthermore, at 2 weeks, the rhBMP-2+ACS group had considerably quicker and larger bone growth regions than the PRF+TCP group. These findings suggest that just impregnating ACS with rhBMP-2 can result in considerable bone regeneration, equivalent to PRF+TCP [39].

Alhussaini examined 24 dental implants that had BMP, 27 dental implants that contained PRF, and 51 dental implants that did not contain BMP or PRF (control group). The bioactive substance having the highest effect on implant stability was determined using statistical analysis. Six weeks following implant placement, the implant stability of the rhBMP-2 group was considerably superior than that of the PRF and control groups. The impact of rhBMP-2 on implant stability was extremely significant and superior to that of the other groups at 12 weeks. Dental implants covered with BMP had a better effect on stability than those coated with PRF alone or without PRF or BMP, according to Alhussaini [40].

4. CONCLUSION

BMPs outperformed PRFs in terms of radiographic bone fill after 6 months. In terms of hard tissue regeneration, BMPs were shown to be superior than PRFs. PRFs, on the other hand, were beneficial in soft tissue repair. When BMPs were introduced to ACS, bone regeneration was equivalent to PRF when TCP was employed. Implants coated with BMPs would be more stable than those coated with PRFs.

Finally, we can deduce from the research that BMPs have been examined more thoroughly than PRFs and have greater effects in terms of hard tissue regeneration and repair. The fact that PRFs induce improved soft tissue repair, on the other hand, demonstrates how promising PRFs are. Especially when we consider that in implant dentistry, soft tissue healing is more crucial than socket maintenance. More clinical trials are

needed to determine if these components should be used alone or in combination.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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