Odontología (Montevideo). 2024; 2:123
doi: 10.62486/agodonto2024123
ISSN: 3046-4102

REVIEW

Effectiveness of platelet-rich fibrin and chitosan as adjuvants for the treatment of chronic periodontitis

Efectividad de fibrina rica en plaquetas y quitosano como coadyuvantes en el tratamiento de la periodontitis crónica

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Cite as: Izarra J. Effectiveness of platelet-rich fibrin and chitosan as adjuvants for the treatment of chronic periodontitis. Odontologia (Montevideo). 2024; 2:123. https://doi.org/10.62486/agodonto2024123

Submitted: 02-02-2024 **Revised:** 13-05-2024 **Accepted:** 28-08-2024 **Published:** 29-08-2024

Editor: Nairobi Hernández Bridón

ABSTRACT

This article reviews the effectiveness of platelet-rich fibrin (PRF) and chitosan as adjunctive treatments in chronic periodontitis, an inflammatory disease affecting tooth-supporting tissues. Chitosan, a natural biopolymer, has demonstrated antimicrobial and regenerative properties, while PRF facilitates healing by reducing inflammation and deepening tissue attachment. Through a systematic review of recent studies, different parameters such as gingival index, periodontal pocket depth and plaque accumulation were evaluated. The results indicated that both biomaterials significantly improve periodontal treatment outcomes, suggesting their potential as effective adjuvants in periodontal therapy. However, further studies with larger samples are recommended to validate these findings in the long term.

Keywords: Periodontitis; Platelets; Fibrin; Gingivitis; Gingiva; Periodontics.

RESUMEN

El presente artículo revisa la efectividad de la fibrina rica en plaquetas (FRP) y el quitosano como tratamientos coadyuvantes en la periodontitis crónica, una enfermedad inflamatoria que afecta los tejidos de soporte dental. El quitosano, un biopolímero natural, ha demostrado propiedades antimicrobianas y regenerativas, mientras que la FRP facilita la cicatrización al reducir la inflamación y profundizar en la inserción de los tejidos. Mediante una revisión sistemática de estudios recientes, se evaluaron diferentes parámetros como el índice gingival, la profundidad de las bolsas periodontales y la acumulación de placa. Los resultados indicaron que ambos biomateriales mejoran significativamente los resultados del tratamiento periodontal, sugiriendo su potencial como adyuvantes efectivos en la terapia periodontal. Sin embargo, se recomienda realizar estudios adicionales con muestras más amplias para validar estos hallazgos a largo plazo.

Palabras clave: Periodontitis; Plaquetas; Fibrina; Gingivitis; Encía; Periodoncia.

INTRODUCTION

Chronic periodontitis is a type of periodontal disease characterized by inflammation of multifactorial origin that develops from the accumulation of biofilm in the gingival sulcus, generating an immunoinflammatory response that causes the destruction of periodontal tissues or loss of attachment, which is considered a pathognomonic sign of this disease.[1]

Once dental biofilm forms, changes consistent with gum inflammation (gingivitis) begin to occur.[2] If left

untreated, it can spread to deeper structures of the periodontium, forming periodontal pockets that provide a favorable environment for bacterial colonization, leading to the development of periodontitis.[3,4]

Dental biofilm is classified according to its position on the tooth surface as supragingival and subgingival. Supragingival biofilm is located at or above the gingival margin and plays a vital role in developing gingivitis. Subgingival biofilm is found below the gingival margin, between the tooth and the gingival sulcus tissue. It is in contact with the tissues and is essential in destroying soft and hard tissues, which characterizes the different forms of periodontitis.[5]

The main risk factors for periodontitis include microorganisms in the biofilm, hormonal changes, alcoholism, stress, genetic and environmental factors such as cigarette smoking, and systemic diseases such as diabetes mellitus and osteoporosis.[6,7]

The main characteristics of periodontal disease include loss of periodontal support tissue, manifested radiographically by alveolar bone loss and clinically by periodontal pockets and gingival bleeding.[8] Also, gingival enlargement or recession, bleeding of the gums after periodontal probing or in response to a stimulus, and increased tooth mobility and exfoliation may occur in the most severe cases.[9]

The microbiota associated with periodontitis is an abundant supragingival biofilm. Studies of subgingival microorganisms predominant in periodontitis lesions have revealed their great diversity, consisting mainly of anaerobes (90 %), of which 60 % are Gram-negative, 30 % are spirochetes, and very few are cocci. Despite this, there is no direct evidence to conclude that bacterial species initiate the development of the periodontal pocket. The most common periodontopathogens are P. intermedia, A. actinomycemcomitans, P. gingivalis, and T. forsythia.[10,11] In addition, the destruction of periodontal tissues may be due to the action of bacterial enzymes (collagenase, hyaluronidase, protease, chondroitin sulfatase, or endotoxins) that directly digest the tissues, but also to the host's response to these enzymes.[12]

In addition, destructive tissue responses could be triggered by the host's inflammatory and immune reactions.

The sequence of events involved in the development of periodontal disease is analyzed in the stages below. Periodontitis is classified into stages, extent or distribution, and grades. The stages range from one (I) to four (IV), depending on the severity and complexity of the treatment. This corresponds as follows:[12]

- Stage I: Initial periodontitis.
- Stage II: Moderate periodontitis.
- Stage III: Severe periodontitis with potential for additional tooth loss.
- Stage IV: Severe periodontitis with potential for tooth loss.

According to its extent and distribution, it can be classified as localized, generalized, or incisor-molar distribution.

The degree of periodontitis allows the progression of the disease to be measured to determine the behavior of the case, whether the degree of progression is advancing faster than usual in most patients, or whether it is not responding normally to conventional treatment. Risk factors such as general health, smoking habits, or systemic diseases such as diabetes can modify the degree of periodontitis.

- Grade A: No evidence of bone loss on X-ray or clinical attachment level in the last 5 years, large biofilm deposits with low levels of periodontal destruction.
- Grade B: Attachment loss <2 mm in the last 5 years. Destruction is proportional to biofilm deposits.
- Grade C: Loss is ≥ 2 mm in the last 5 years. Destruction exceeds expectations based on biofilm deposits.[11]

Periodontal treatment aims to control infection and eliminate the microbial etiology and risk factors contributing to periodontitis, thereby halting the progression of the disease and preserving both the dentition and hard and soft tissues in a healthy, functional, and aesthetic state.[13]

Periodontal disease treatment is personalized according to the type of periodontitis and risk factors specific to each patient; however, various established parameters are followed. It begins with basic therapy, which includes teaching or correcting the brushing technique, motivating the patient to maintain adequate oral hygiene and plaque control, and managing and controlling their daily habits, such as smoking cigarettes. This is followed by clinical intervention through basic therapy and root planing and scaling (RPS), which is a non-surgical or closed-trap technique based on subgingival instrumentation without gum displacement, which serves to remove calculus deposits, dental biofilm, and its metabolic products from the tooth surface that cause an inflammatory response in the adjacent periodontal tissues, as well as obtaining a smooth, hard surface that promotes healing and maintenance of the root surface without biofilm.[13,14]

Basic therapy includes polishing fillings and overhanging prostheses, inactivating open caries, and extracting teeth without bone support. After basic periodontal treatment, the patient is reevaluated after 30 days (due to the connective tissue healing period) to determine whether complementary therapies are necessary.

In more complex cases, where there are deeper periodontal pockets, multiradicular teeth with furcation involvement, or bone defects, and where complete removal of calculus and subgingival biofilm cannot be

achieved, surgical periodontal treatment should be performed, involving open-flap RAR to expose areas that are difficult to access, resulting in a more significant reduction in probing depth and clinical attachment gain.[14,15]

Gingival index (Löe and Silness)

The gingival index is used to assess the intensity and amount of gingival inflammation to compare gingival health before and after phase I of periodontal treatment or before and after surgical treatment.[16]

Procedure:

a) Assess the inflammation of each of the four gingival areas of the tooth: vestibular, mesial, distal, and lingual, and assign a value from 0 to 3.

b) Bleeding is assessed by sliding the periodontal probe along the soft wall of the gingival sulcus.

c) The values for the four areas are added together and divided by four to give a value for the tooth.

d) The patient's gingival index is obtained by adding the values for the teeth and dividing by the number of teeth examined.[16]

The assessment can be performed on all teeth or only on selected teeth.

Values:[17]

- 0,1 to 1,0: mild inflammation.
- 1,1 to 2,0: moderate inflammation.
- 2,1 to 3,0: severe inflammation.

Radiographic characteristics:[9]

- Horizontal bone destruction at the beginning and vertical in advanced stages.
- Interruption and decrease in bone crest height.
- Furcation involvement is observed in moderate and severe periodontitis
- Secondary occlusal trauma.

Through tissue engineering, techniques have been proposed to aid in the treatment of chronic periodontitis and its consequences, including the use of resorbable biological or alloplastic matrices, alone or seeded with living cells, to fabricate three-dimensional structures that serve as biostimulating implant material.[18]

Due to their biological similarity to the organism, a wide range of biocompatible biomaterials exist. These materials also provide an antimicrobial effect and tissue adhesion. Among these biomaterials are chitosan and platelet-rich fibrin.

Chitosan is considered a candidate biomaterial for use in periodontics. It is an antimicrobial biopolymer that interacts with tissues and can behave as a suitable microenvironment for cell proliferation and growth. It also releases bioactive agents such as growth factors and promotes tissue healing and regeneration.[2]

Chitosan is a natural polysaccharide whose structure corresponds to a copolymer of N-acetylglucosamines and glucosamines. It is biodegradable, biocompatible, and obtained from chitin, which forms part of the exoskeleton of crustaceans, insects, and fungal cell walls. Due to the compatibility of chitosan with many organic compounds such as surfactants, starches, quaternary ammonium salts, cationic and non-ionic polymers, and polyvalent anions, gels and precipitates can be formed.[19]

Chitosan can behave as a suitable microenvironment for the proliferation and growth of cell colonies, such as osteoblasts, which exhibit high alkaline phosphatase activity and stimulation of osteocalcin synthesis; these are indicators of bone tissue regeneration.[20]

It also has hemostatic properties, and its mechanism of action involves an interaction between the cell membrane of erythrocytes and chitosan, independent of the classic coagulation cascade. Furthermore, it is cytocompatible in tests, where cells adhere strongly and proliferate adequately, confirming their ontogenic and neochondrogenic capacity. It also supports and modulates the growth and proliferation of vascular cells, neurons, fibroblasts, epithelial cells, osteoblasts, and chondrocytes.

The antimicrobial effect of chitosan has been extensively studied and proven over time; however, this biopolymer's mechanism of action has not yet been well elucidated, and despite having the conditions to produce it, it is currently not found in Argentina.

On the other hand, fibrin is the active form of a plasma molecule called fibrinogen. This soluble fibrillar molecule is massively present in plasma and the alpha granules of platelets and plays an essential role in platelet aggregation during hemostasis. It becomes a biological glue capable of consolidating the initial group of platelets, forming a protective wall along vascular ruptures during coagulation.[21]

A blood sample is taken from the patient to obtain FRP, and 10 ml is placed in test tubes without any anticoagulants. It is immediately centrifuged at 2000 rpm for 10 minutes. This process activates endogenous thrombin and transforms fibrinogen into fibrin, producing a fibrin clot located between the layer of red blood

cells and the acellular plasma.[22] The clot obtained is removed with forceps 1 millimeter below the red line, thus obtaining dense, elastic, suturable, biocompatible, and resorbable fibrin that can be used numerous times as a biological membrane.[23] To obtain a fibrin membrane, the clot can be placed in an FRP box, then covered with the compressor and the lid, or it can also be placed between two sterile gauze pads or two slides until a membrane is formed.[24,25]

The use of FRP in periodontics is a current and interesting trend. In recent years, studies have demonstrated the versatility and efficacy of FRP in treating gingival recessions.[26]

Although there is clinical evidence on the effect of these biomaterials in periodontics, it is still an emerging field, and most studies evaluate these biomaterials separately, sometimes obtaining them through complex processes that involve high costs. The present study aims to evaluate the effectiveness of platelet-rich fibrin and chitosan as adjunctive therapy in treating chronic periodontitis through a literature review.

METHOD

The following work refers to a theoretical discussion, conducting research through a bibliographic search of scientific articles in recent years in different digital databases such as Scielo, Medline, Lilacs, Pubmed, Google Scholar, digital libraries, Acta odontológica venezolana, in English and Spanish using the following descriptors: "Platelet-rich fibrin"; "chitosan"; "chronic periodontitis."

Inclusion criteria:

- Scientific articles on patients diagnosed with chronic periodontitis.
- Any research study (clinical practice, clinical trial, observational study) will be valid.

Exclusion criteria:

- Articles that do not report clinical data.

A total of 340 potential articles were examined in different databases, such as Scielo, Medline, Lilacs, Pubmed, Google Scholar, digital libraries, and Acta odontológica Venezolana in English and Spanish using the following descriptors: "Platelet-rich fibrin"; "chitosan"; "chronic periodontitis." Each study's title, abstract, and full text were carefully analyzed, and only 49 articles were selected. Thirteen articles were excluded based on their title, five based on the abstract, twenty based on the complete text, and five were not considered due to their publication date (before 2014). Quality assessment and data extraction were performed on the six randomized controlled trials.

RESULTS

The results of the systematic search show the effectiveness of fibrin compared to chitosan in patients with periodontal disease. The following parameters were evaluated: bleeding index, gingival index, periodontal pocket depth, attachment level, and the bacterial plaque index (O'Leary) in various studies conducted by different authors. This allowed for an evaluation of the two groups' initial and final status after treatment.

The studies conducted by the aforementioned authors showed a reduction in bleeding with the application of chitosan as a complement to conventional therapy. In addition to acting as an antimicrobial, regenerator, and biocompatibility, chitosan also demonstrated a reduction in bleeding in relation to PRF.

Furthermore, the application of chitosan and FRP reduced gingival inflammation when observing the gingival index. When measuring periodontal pockets, a clinical improvement was noted in terms of periodontal probing depth and an increase in clinical attachment levels, stimulating the proliferation of gingival fibroblast cells in the groups to which chitosan and FRP were applied.

Finally, an improvement in bacterial plaque accumulation was observed with the application of chitosan and in studies conducted using FRP.

Table 1. Research studies on the application of platelet-rich fibrin (PRF) and chitosan.

Researchers	Study design	Population	Material	Index	Conclusions
Lauritano, 2020[27]	Systematic review	72 patients	Chitosan	Hemorrhagic	Greater potential for periodontal regeneration and hemostatic activity
Vento, 2015[28]	Experimental	21 patients	Fibrin (FRP)	Hemorrhagic	The experimental group showed a greater reduction in bleeding than the control group
Suárez, 2017[29]	Experimental	12 laboratory rats	Chitosan	Gingival index	Greater number of cells differentiated into the osteoblastic lineage more rapidly and their growth was accelerated in the presence of chitosan

Simran, 2024[30]	Clinical trial	13 patients	Fibrin (FRP)	Probing depth	The complementary use of PRF improved healing, reduced pocket depth, decreased tissue morbidity, and minimized gingival recession
Costa, 2014[31]	Experimental	5 eriodontal pathogens obtained from cultures	Chitosan	Plaque index	Chitosan showed a strong effect against periodontal pathogens, thus inhibiting biofilm formation
Vaca, 2017[32]	Experimental	9 patients	Chitosan	Plaque index O Leary	Chitosan exhibits potent bacterial plaque reduction and antibacterial activity against several oral pathogens

DISCUSSION

Chronic periodontitis is an infectious and inflammatory disease of the supporting tissues of multifactorial origin closely related to the accumulation of dental biofilm in the gingival sulcus. So, conventional treatment is based on controlling or eliminating the bacterial load in the periodontal pocket.[25,26,33]

The current trend is to seek adjuvant treatments with fewer side effects to obtain better results,[33] as the aim is to contribute to the recovery of lost periodontal tissue.[34,35]

Bleeding Index

The use of fibrin has been evaluated, including by Vento in 2015, who used fibrin as an adjunctive therapy to the surgical phase of chronic periodontitis treatment and observed that the experimental group had a more significant reduction in bleeding than the control group.[28]

On this same aspect, Lauritano et al., in 2020, studied that the efficacy of chitosan in periodontal tissue engineering has been widely demonstrated. Chitosan is a naturally occurring polymer with biodegradable, biocompatible, and biologically renewable properties. It is bacteriostatic and non-toxic and has hemostatic and mucoadhesive properties.[27]

Gingival Index

About chitosan, Suárez et al. in 2017 reported that the tissue reaction to the chitosan liposomal scaffold is a result that can be explained by the rapid differentiation of a more significant number of cells in the osteoblastic lineage and their more accelerated growth in the presence of chitosan, which is rich in glucosaminoglycan, which can be extrapolated to the induction produced by native glycosaminoglycans found intracellularly in connective tissue mast cells and other hematopoietic cells, participating in the immune and inflammatory response, so that improvement of the disease would be associated with the application of chitosan as a complementary treatment to scaling and root planing.[29] Similarly, Vento in 2015 observed that gingival inflammation decreased significantly in the group to which fibrin was applied compared to the control group.[28]

Periodontal pocket depth and attachment level

Suárez et al. conducted a study in 2017 that found that chitosan promotes cell adhesion, diffusion, viability, and differentiation. This stimulation occurs due to the polycationic nature of chitosan, which promotes electrostatic bonding with glucosaminoglycans (anionic molecules) and also binds to growth factors (signaling molecules). This stimulates various cells, largely fibroblasts, which promote angiogenesis. Greater vascular nutrition leads to faster repair. [29] In addition, this fibroblast stimulation accelerates collagen matrix deposition.

Results obtained by Vento 2015 showed clinical improvement in periodontal pocket depth in cases where fibrin was applied compared to the control group that received only root planing and scaling.[28]

Simram et al. 2024 studied the complementary use of PRF, which improved healing, reduced pocket depth, decreased tissue morbidity, and minimized gingival recession. This study concludes that PRF placement is effective in 5- to 6-mm pockets, potentially reducing the number of periodontal treatment sessions needed to close the pockets.[30]

Bacterial plaque index (O'Leary)

Costa et al. 2014 studied in vitro the antimicrobial effect of chitosan on five biofilm-forming periodontal pathogens (Porphyromonas gingivalis, Prevotella intermedia, Prevotella buccae, Tanerella forsythensis, and Aggregatibacter actinomycetencomitans) and found that chitosan showed a strong effect against periodontal pathogens through interference in bacterial coaggregation by inhibiting violacein from Clostridium violaceum, thus inhibiting biofilm formation.[31] Vaca et al. in 2017 conducted a study in which chitosan exhibited a potent bacterial plaque reduction action, as well as antibacterial activity against several oral pathogens such as Actinobacillus actinomycetemcomitans, Streptococcus mutans, and Porphyromonas gingivalis, all of which are

involved in plaque formation in periodontitis.[32]

Furthermore, in 2024, Simran et al. conducted a randomized clinical trial. They observed a significant reduction in plaque index at sites treated with FRP compared to those treated with SRP (scaling and root planing) alone, suggesting that FRP may be an effective adjunct to control plaque accumulation and improve periodontal treatment outcomes.[30]

CONCLUSION

Based on systematic research conducted on the effectiveness of platelet-rich fibrin and chitosan as adjuvants in the treatment of chronic periodontitis, it can be concluded that they reduce bleeding on probing, gingival index, probing depth, and, in the case of chitosan, a reduction in bacterial plaque accumulation without causing adverse effects in patients, and therefore its use is recommended.

Furthermore, experimental studies with a large population are suggested to evaluate the results in the medium and long term.

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FINANCING

The authors did not receive funding for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

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