Use of platelet-rich fibrin (PRF) in regenerative endodontic procedures

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RESUMO
O objetivo do presente trabalho foi avaliar o uso e a aplicabilidade das plaquetas ricas em fibrina (PRF) em procedimentos regenerativos endodônticos. Os critérios de inclusão da pesquisa foram: estudos que informem o uso do PRF como tratamento alternativo para regeneração endodôntica, publicados entre 2013 e 2023. Os critérios de exclusão foram: Teses, editoriais, monografias, dissertações, artigos incompletos eletronicamente e aqueles que não responderam à questão norteadora. É uma revisão integrativa da literatura, o presente estudo não foi submetido ao comitê de ética, no entanto, as ideias dos autores sobre as publicações utilizadas no desenvolvimento deste estudo permaneceram. Para compor esta revisão, utilizamos os portais eletrônicos: PubMed, Biblioteca Virtual de Saúde e Cochrane Library, com os descritores: Regeneração tecidual guiada; Fibrina rica em plaquetas; Endodontia, no qual foram selecionados 21 artigos para o desenvolvimento desta revisão. Desta maneira, o PRF mostrou-se eficaz nos tratamentos endodônticos regenerativos, reduzindo as lesões periapicais, auxiliando na formação da raiz e fechamento apical. Ademais, é possível evidenciar que a sua atuação na endodontia tem altos potenciais, destinando-se tanto ao âmbito intracanal como a condutas que requerem intervenções paredendônticas como as microcirurgias.

Palavras-chave: regeneração tecidual guiada, fibrina rica em plaquetas, endodontia.

ABSTRACT
The aim of this study was to evaluate the use and applicability of fibrin-rich platelets (PRF) in regenerative endodontic procedures. The research inclusion criteria were: studies that report the use of PRF as an alternative treatment for endodontic regeneration, published between 2013 and 2023. The exclusion criteria were: Theses, editorials, monographs, dissertations, electronically incomplete articles and those that did not respond to the guiding question. It is an integrative literature review, the present study was not submitted to the ethics committee, however, the authors' ideas about the publications used in the development of this study remained. To compose this review, we used the electronic portals: PubMed, Virtual Health Library and Cochrane Library, with the descriptors: Guided tissue regeneration; Platelet-rich fibrin; Endodontics, in which 21 articles were selected for the development of this review. In this way, PRF proved to be effective in regenerative endodontic treatments, reducing periapical lesions, helping in root formation and apical closure. In addition, it is possible to show that its performance in endodontics has high potential, aimed both at the intracanal scope and at procedures that require endodontic interventions such as microsurgery.

Keywords: guided tissue regeneration, platelet-rich fibrin, endodontics.

1 INTRODUÇÃO
Endodontic therapy has among its main objectives, to conduct the chemical-mechanical debridement of the root canal system to reduce intracanal microbial load at an
insufficient level of inducing a pathological response. In this context, it is necessary to have theoretical, clinical and scientific knowledge to provide an effective intervention (Pires, Martins, Baruwa, Pereira & Ginjeira, 2022). New therapeutic methods have gained space in endodontics to improve clinical management and add up interventions. Fibrin-rich platelet (PRF) stands out in this medium, as it denotes biocompatible properties, concentrates and allows a longer release of growth factors and acts in the modulation of the tissue repair process (Machado, Bastos, Almeida, Padilha & Limoeiro, 2020).

To obtain the PRF it is necessary to collect the patient's blood a few minutes before the procedure, in a ratio of approximately 10 ml, placing it in a glass test tube, without anticoagulant, in which such material should be taken immediately to the centrifuge at 2400 rpm for 12 minutes. The result is the production of a biological gel that has the ability to consolidate the beginning of platelet aggregation, constituting a protective barrier against vascular violations during the coagulation process, and because this substance is already aggregated, the first scar matrix at the injury site will already be constituted (Costa, Resende, Assis, Barros & Junior, 2019). The PRF consists of a cluster of cytokines, glycoproteins and glycans encased in a network of fibrins that act synergistically in the tissue healing process as a natural structure guiding angiogenesis, which enriches the rate of tissue differentiation (Hotwani & Sharma, 2014).

According to Meza et al. (2019), in the past decade began research and the use of platelet-rich fibrin (PRF) as a framework for the revascularization of immature permanent teeth with pulp necrosis, and over time it has been validated that the PRF is an excellent biomaterial that can be used for the pulp-dentin complex. Thus, growth factors stimulate cell proliferation and differentiation.

Bio-based regenerative endodontic procedures (REPs) are gaining popularity in the area of endodontics. The possible success of REPs depends on the effective implementation of tissue engineering, adequate disinfection and coronal protection to maintain the disinfected environment. And the 3 pillars for the engineering of these tissues are stem cells, scaffolding and growth factors. (Markanday & Adhikari, 2022).

Regenerative processes in endodontics involve the use of materials that promote healing and repair of the dentin-pulp complex in infected dental tissues. These procedures, known as regenerative endodontics, include techniques such as pulp implantation and revascularization, which in turn was implemented in the clinical environment, aiming to prevent invasive instrumentation and radiographic exposure. The revascularization process is performed by the reimposition of β and T lymphocytes, which help in the defense against
pathogens that lead to pulp damage (Arshad, Tehreem, Ahmed, Marya, & Karobari, 2021).

In endodontics, there are many forms of interventions, when orthograd or retreatment treatment is unsuccessful or unfeasible, endodontic microsurgery enters as a treatment option, and it is also possible to combine regenerative endodontic procedures (REPs) with apical surgery. Thus, success in cases that require more complex management, require technologies and scientific knowledge to add up. Fibrin rich in leukocyte platelets (L-PRF) has been studied and investigated, in which it has been shown to be an important additive and provide an innovative intervention strategy that can reveal benefits both in the intracanal and in periapical regions (Pinto et al., 2017).

Endodontic microsurgery is a predictable procedure that treats recurrent apical periodontitis. The procedure is indicated when orthoped access to the apical part of the root canal system, when conventional technique is not possible. Reasons can change from unnecessary removal of a healthy coronal restoration to irreparable damage, such as fractures or disassembly of prostheses with extensive coronal pin. (Popowicz, Palatyńska-Ulatowska, & Kohli, 2019).

2 OBJECTIVE

The aim of this study was to evaluate the use and applicability of fibrin-rich platelets (PRF) in endodontic regenerative procedures.

3 METHODOLOGY

This work is an integrative review of the literature developed in six phases, namely: a) development of the research question; (b) definition of the databases and eligibility criteria used; c) definition of the information to be extracted from the work taken from the search platforms; d) analysis of the included studies; e) interpretation of the results; f) presentation of the synthesis of knowledge (Whittemore & Knafl, 2005).

The research question was raised according to the Population Context of Interest (PICo) strategy (Lockwood, Dos Santos, & Pap, 2019). Thus, the following structure was considered: P - Guided tissue regeneration (PRF), I-Fibrin rich in platelets and Co-Endodontics. Thus, the following question was formulated: "Can the use of fibrin-rich platelets be useful and effective in endodontic procedures?" researchers, composed of two members in each group, respectively, conducted the searches and selection of the studies, where they formulated the steps and performed them separately, in order to identify possible divergences in the results obtained.
The inclusion criteria of the research were: studies that report the use of PRF as an alternative treatment for endodontic regeneration, published between 2013 and 2023. Exclusion criteria were: Theses, editorials, monographs, dissertations, articles incomplete electronically and those that did not answer the guide question. is an integrative review of the literature, the present study was not submitted to the ethics committee, however, the authors’ ideas about the publications used in the development of this study remained. To make up this review, we used the electronic portals: PubMed, Virtual Health Library and Cochrane Library, with the descriptors: Guided tissue regeneration; Fibrin rich in platelets; Endodontics (figure 1).

**Figure 1: Flowchart of the search strategy.**

![Flowchart of the search strategy](image)

Source: Authors (2023).

4 RESULTS AND DISCUSSION

The bibliographic survey of this study addressed the period of the work research from 2013 to 2023, a total of 30 publications were found, which after the application of the inclusion and exclusion criteria, 21 articles were chosen to make up this review, in which the study design was defined by: three literature reviews, thirteen case reports, a controlled multicenter clinical trial, a prospective controlled trial, a single blind randomized prospective trial, a randomized controlled prospective trial, and an in vitro trial. Table 1 presents the 21 selected...
publications, according to authors, year of publication, objective, type of study, sample and main findings.

### Tabela 1: Summary of selected studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Objective</th>
<th>Methodology</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotwani e Sharma (2014)</td>
<td>Present the various perspectives of THE PRF and its clinical applicability for regenerative endodontic therapy.</td>
<td>Literature review.</td>
<td>The PRF was considered appropriate for regenerative endodontics since it contains growth factors and can be a promising tool to enrich the rate of tissue differentiation. It may also be associated with Hydroxyapatite (HA) crystals, which accelerates the resorption of crystals and induces a rapid rate of bone formation.</td>
</tr>
<tr>
<td>Nagaveni et al. (2015)</td>
<td>Describe the efficacy of PRF in the treatment of a deep intraosseous defect associated with an endoperium lesion in an immature right first lower premolar of a 12-year-old patient.</td>
<td>Case report.</td>
<td>Periodontal regeneration is possible using PRF and is an ideal biomaterial for routine clinical use in the regeneration of bone defects in children. However, controlled clinical trials are highly essential to assess whether the addition of PRF alone or in combination with bone grafts significantly increases bone formation and maturation.</td>
</tr>
<tr>
<td>Dhiman et al. (2015)</td>
<td>To evaluate the results of platelet-rich fibrin healing (PRF) in periapic surgeries involving apicomarginal defects and compare these results with surgeries that do not use any guided tissue regeneration technique.</td>
<td>Randomized controlled prospective study.</td>
<td>The results of the present study should be extrapolated with caution. Although this study observed high success rates of apical surgery in apicomarginal defects, even without the use of any barrier membrane, most of the defects recorded in the study were of primary endodontic origin, with no or minimal periodontal involvement. Within the limits of this study, it can be concluded that a high success rate can be achieved in apicomarginal defects with endodontic microsurgery, and the addition of PRF may not necessarily improve the result.</td>
</tr>
<tr>
<td>Tandon (2015)</td>
<td>Present an attempt to evaluate the healing kinetics</td>
<td>Case report.</td>
<td>Advantages of using this platelet and immune</td>
</tr>
</tbody>
</table>
of the combination of PRF and xenograft (G-graft) in the treatment of perio-endo lesions.

Priya et al. (2015)  
It reports in detail the preparation, effects, and endodontic applications of PRF.

Literature review.  
Considering the versatility and biocompatibility of PRF, it becomes a valuable adjunct in endodontic procedures. Clinical and radiographic evaluations showed a favorable response to this type of material.

Ray et al. (2016)  
It reports a revascularization protocol through a case in which the PRF was used as an autologous structure for traumatized, necrotic immature teeth with incomplete root development.

Case report.  
Through follow-up reports, including clinical examination and radiographs, a marked improvement was observed in the condition of the traumatized tooth after the use of the PRF.

Bakhtiar et al. (2017)  
The objective of this study was to report the clinical and radiographic results of a regenerative procedure using PRF in teeth with necrotic pulps.

Case report.  
Based on the follow-up carried out for 12 months, the PRF proved to be an effective structure in the regeneration of pulp content in immature teeth with necrotic pulps. Radiographs revealed an improvement in periapical lesions, greater root development and apical closure in all cases.

Betancourt et al. (2017)  
Report the clinical efficacy of platelet-rich fibrin and leukocytes (L-PRF) in the treatment of a combined endoperiodontal lesion of a first upper premolar.

Case report.  
In this case report, a superior premolar with severe endoperiodontal lesion was successfully treated with conservative treatment with L-PRF.

Zhou et al. (2017)  
Evaluate the concomitant use of platelet-rich fibrin (PRF) with a blood clot (BC) in RET in relation to periapical healing, root development and structural reinforcement of the tooth.

In Vitro study.  
The combination of PRF with BC or just BC could improve periapical healing, induce root development and strengthen dental structure. No additional PRF for BC benefit in RET was found.

Wadhw et al. (2017)  
To evaluate the healing of periapical lesion along with apicomarginal defect using FibrinRica in Platelets (PRF)

Case report.  
The PRF plays an important role in the healing of apicomarginal defects, which was evident in the present
as a membrane in periapical surgery of the lower first molar.

<table>
<thead>
<tr>
<th>Author(s) (Year)</th>
<th>Description</th>
<th>Study Type</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>Pinto et al. (2017)</td>
<td>Report an innovative regenerative endodontic therapy using L-PRF in the root canal of an immature tooth with invaginatus dens and asymptomatic apical periodontitis with extensive lesion.</td>
<td>Case report.</td>
<td>Clinical evaluations at 6 months and 1 year after the intervention revealed no symptoms. X-rays showed that the lesion was resolved. Conical beam images indicated that the length of the root increased, and the walls became thicker. Sensitivity tests were positive and doppler laser flowmetry showed positive blood flow.</td>
</tr>
<tr>
<td>Costa et al. (2019)</td>
<td>Report a periodontal clinical approach of periapical cyst enucleation, subsequent cavity filling with biomaterial and Fibrin rich in platelets and leukocytes (L-PRF).</td>
<td>Case report.</td>
<td>L-PRF proved to be an important adjuvant factor to Lumina-Bone (graft), in which it was summed up in the control of the inflammatory condition, assisted in the repair process and stabilization of grafting material, enabling a better prognosis.</td>
</tr>
<tr>
<td>Ulusoy et al. (2019)</td>
<td>It compared the clinical and radiographic performance of regenerative endodontic procedures using PRF.</td>
<td>Controlled prospective study.</td>
<td>The PRF may offer a longer and richer exposure of cell growth factors, favoring the secretory activity of cells that differentiate within the channel space.</td>
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<tr>
<td>Popowicz et al. (2019)</td>
<td>Describe root apex surgery with the aid of a planning software, with a modified soft tissue access and add a biocompatible material to aid in healing.</td>
<td>Case report.</td>
<td>The findings showed potential for endodontic microsurgery directed not only in execution, but also with a positive result in a short follow-up period. The preservation of the cortical plate to be used as autologous graft was an additional advantage in this technique and the approach of addition of the PRF was summation.</td>
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<tr>
<td>Meza et al. (2019)</td>
<td>The aim of this case report was to describe a regenerative autologous cell therapy using mesenchylysed stem cells of inflamed dental pulp and fibrin rich in leukocyte platelets (L-PRF) in a mature tooth.</td>
<td>Case report.</td>
<td>L-PRF can provide an innovative alternative treatment strategy for complex clinical cases in teeth with extensive apical lesions and an immature apex. In addition, several case reports have described the use of L-PRF as an efficient and safe biomaterial.</td>
</tr>
<tr>
<td>Authors (Year)</td>
<td>Title</td>
<td>Study Design</td>
<td>Summary</td>
</tr>
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<tr>
<td>Kandemir et al. (2020)</td>
<td>Evaluate regenerative endodontic therapy of immature permanent teeth using platelet-rich fibrin (PRF) in 36-month follow-up periods.</td>
<td>Case report.</td>
<td>After the 36-month evaluation period, the dental elements did not respond to the vitality test (ice cream and electric), but there was an evident improvement in periapical lesions.</td>
</tr>
<tr>
<td>Machado et al. (2020)</td>
<td>To present the use of L-PRF in a periodontic surgery, to bone repair.</td>
<td>Case report.</td>
<td>It became evident that L-PRF has a beneficial utility in cases of periodontic interventions and that its high regeneration potential and growth factors provided for a complete tissue regeneration of the area involved by the lesion within 190 days.</td>
</tr>
<tr>
<td>Meschi et al. (2021)</td>
<td>Evaluate the impact of platelet-rich fibrin and leukocytes (LPRF) on regenerative endodontic procedures (REPs) of immature permanent teeth in terms of periapical bone healing (PBH) and added root development.</td>
<td>Controlled multicenter clinical trial.</td>
<td>REP (without LPRF) is a viable treatment option to obtain BHP, cure clinical symptoms and assist in DR necrosis of immature permanent teeth. However, all teeth analyzed survived up to 3 years post-REP and, in case of failure, apicification helped preserve them. Caution is required when evaluating REPs with PRs.</td>
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<tr>
<td>Arshad et al. (2021)</td>
<td>It aims at the current uses of PRF in regenerative endodontic dentistry and its application with future recommendations and limitations.</td>
<td>Literature review.</td>
<td>It was evidenced that PRF acts as a matrix for internal tissue growth, rich in growth factors, increasing cell proliferation and differentiation, which makes it ideal for revascularization of immature permanent teeth with necrotic pulp.</td>
</tr>
<tr>
<td>Markanday e Adhikari (2022)</td>
<td>Compare the clinical and radiological results of regenerative endodontic procedures (REPs) using blood clots (BCs), platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) by intraoral periapical radiography (IOPAR) and cone-beam computerized tomography (CBCT).</td>
<td>Single blind randomized prospective clinical trial.</td>
<td>REPs have proven to be a viable treatment option for non-vital mature and immature teeth with periapical pathology.</td>
</tr>
<tr>
<td>Pires et al. (2022)</td>
<td>Present 2 cases of endodontic microsurgery of upper lateral</td>
<td>Case report.</td>
<td>The use of L-PRF as a bone filler and barrier membrane</td>
</tr>
</tbody>
</table>
Synthesized by the homologated plasma, the PRF is an unnatural biomechanical complex, formed after centrifugation of blood of human origin, which is composed of numerous cytokines, growth factors (GF) and platelets resulting from a polymerization reaction, being totally discarded the use of any anticoagulants for its production. The main growth factors resulting from PRF are: platelet-derived growth factor (PDGF), insulin growth factor-1 (IGF-1), vascular endothelial growth factor (VEGF), β-growth factor (TGF-β), fibroblast growth factor (FGF) and epidermal growth factor (EGF) are cytokines that contribute to the proliferation of osteoblasts, tissue regeneration, angiogenesis and collagen formation (Arshad et al., 2021).

In addition to its "soil" application in immature teeth with pulp necrosis, iatrogenic perforation of the pulp floor and in periapical lesion treatments, PRF can also be combined with other elements such as hydroxyapatite crystals, tricalcium beta phosphate (β-TCP) and mineral trioxide aggregate (MTA), which can amplify cell proliferation and differentiation, induce bone neoformation and regeneration of the dentin-pulp complex (Hotwani & Sharma, 2014). The study by Priya et al. (2015) highlights that PRF has no cytotoxic effects on dental pulp cells and also increases the number of secretory cells of osteoprotegerin, a natural protein that inhibits the differentiation of osteoclasts.

The study by Kandemir et al. (2020) reported the case of 3 patients who underwent endodontic treatment due to periapical injury in an immature permanent dental element, who after the vitality tests were diagnosed with pulp necrosis. The treatment of choice selected for all dental elements was regenerative endodontic therapy (RET), following the protocol determined by the American Association of Endodontics (AAE). In the first session, the dental elements had their cavities accessed and the canals were irrigated with 1.5% sodium hypochlorite and after placement of intracanal medication with the triple antibiotic paste (TAP) the accessed cavity was temporarily sealed with glass ionomer. In the following session, the PRF was obtained from the respective patients and apically condensed in the dental elements channel. After a 36-month follow-up, the dental elements did not respond to the pulp sensitivity.
test, but radiographically it was possible to observe a significant regression of the periapical lesions.

Similarly, Meza et al. (2019) addressed in a case report of a 50-year-old patient diagnosed with irreversible pulpitis in 28, a regenerative autologous cell therapy using inflamed dental pulp stem cells (DPSCs) and leukocyte platelet-rich fibrin (L-PRF). For this, the inflamed dental pulp was extracted and transported to a laboratory, in which the isolation and culture of the DPSCs were made. Follow-up was performed in an interval of 6 months and 3 years. During the follow-up period, the results were benefits, in which ct scans, pulp sensitivity and vitality tests indicated a normal response to percussion and palpation tests. However, the tooth showed a late response to cold, but the electric pulp test was responsive. X-rays and ct scans revealed that the periapical region remained normal. Thus, the study revealed an alternative potential use for pulpitis treatment in permanent teeth.

Pinto et al. (2017) showed that platelet-rich fibrin (PRF) has potential benefits in regenerative endodontic procedures (REPs) and may help in the formation of apical root in teeth with incomplete roots and extensive periapical lesions, as well as help in optimal bone healing. For Markanday and Adhikari (2022), The 3 key elements for tissue engineering are stem cells, scaffold and growth factors, and the PRF included in the latter, which acts as a signaling molecule, induces migration, adhering, proliferation and cell differentiation.

Similarly, Machado et al. (2020) pointed out that regenerative endodontics has denoted L-PRF as a promising substance capable of potentiating the process of improvement of the clinical picture, whether in intracanal or parendodontic interventions, due to osteogenic, biocompatible potentials, induction of new cell formation and regenerative factors. Moreover, the use of such additive allows the release of growth factors slowly during the healing of the lesion and from this step occurs the impediment of the proliferation of microorganisms from the oral epithelium and the gingival connective tissue to the pathology area.

In this context, Pires et al. (2022) documented 2 cases involving 2 upper lateral incisors with unsuccessful endodontic treatments and loss of vestibular cortical bone plate, in which L-PRF was applied as bone filling and barrier membrane in the large periapical defects. In view of the endodontic retreatment and the application of this approach in both cases, imaging tests demonstrated that the addition of L-PRF was a viable and beneficial option to achieve a successful result. However, the authors highlighted that there was evidence of scar tissue formation in 1 of the cases. In consonance, Costa et al. (2019) also explored the advantages of PRF, in the case of a 62-year-old patient with the presence of radiolucent lesion of defined limits involving the root apexes of teeth 33 and 34, for this intervention we opted for
Parendodontic surgery, in which l-PRF insated as an adjuvant to the bone graft and helped in the inflammatory control, in the repair process, enabling a better prognosis.

Synergistically, Nagaveni et al. (2015) described the efficacy of PRF in the treatment of a deep intraosseous defect associated with an endoperium lesion in an immature right first lower premolar of a 12-year-old patient. A newly prepared autologous PRF membrane was placed in the bone defect after debridement. Clinical and radiographic follow-up was performed at regular intervals, which revealed absence of pain and periodontal regeneration. In addition, the authors emphasized that the only disadvantages of the use of PRF in children is the need for invasive blood collection procedure and the accuracy of specific equipment for its processing. However, the disadvantages still become small compared to improved healing and the regenerative responses obtained with its addition.

Dhiman et al. (2015) conducted a prospective randomized controlled study with 30 patients who had been referred for periradicular surgery with diagnosis of chronic apical periodontitis and apicomarginal communication, both groups of 15 patients underwent apical endodontic microsurgery, and the test group received the PRF as an adjuvant. The patients were followed and x-imagesred for 0, 3, 6, 9 and 12 months, after this period the probing depth, clinical insertion level, gingival marginal position and size of the periapical lesion were again evaluated. Using these parameters together with the success rate of both groups, it was concluded that the addition of the PRF may not promote the healing of apicomarginal defects of endodontic origin.

Betancourt et al. (2017) reported in their study that in 2 cases of endoperiodontal lesions, L-PRF and PRF were used to treat them. The tooth presented a deep abfraction in the vestibular face without mobility but revealed a deep bag with 11mm on the vestibular mesial face and 14mm on the mesio-palatine face. Thus, the endodontic treatment with periodontal access was performed in the patient with the use of autologous L-PRF, and after surgery was observed for 3 and 6 messes with conical beam computed tomography exams that there was no bone regeneration in the tooth. Nevertheless, periodontal examination showed that there was a significant improvement in the depth of the grooves. Therefore, the authors reveal that there is a favorable prognosis for this type of case with the use of autologous L-PRF, oppositely being done extraction and implanting, commonly done in these types of cases.

In this sense, Wadhwa et al. (2017) showed that the presence of an apicomarginal defect was directly linked to the failure of endodontic treatment. In the present study, the authors describe that the PRF played a major role in the healing of the apicomarginal defect in the region of the lower first molar of this clinical case, without the use of any type of bone graft.
Subsequently, the prf application at 3 months had a probing depth advance from 10mm to 2mm and the result after 18 months was from 2mm to 0mm. The reasons for the success of this case were given by the immunoregulatory action of the PRF, as well as by the removal of the infection from the site, thus promoting connective tissue and the bone formation of the adjacent healthy periodontum.

Tandon (2022) explained that perioendolesions develop by periodontal destruction by apicalally combining with an existing periapical lesion or an endodontic lesion with an existing periodontal lesion. And to treat this type of lesion it is necessary to do the endodontic treatment and periodontal regenerative treatment, to disinfect the canals and then periodontal surgery to remove necrotic soft tissues, after this stabilize with orthodontic fixation apparatus this dental element. Second, the integration of this fibrin network into the regenerative site facilitates cell migration, particularly to the endothelial cells necessary for neoangiogenesis, vascularization and graft survival. Third, as the fibrin matrix is reabsorbed, it gradually releases platelet cytokines, platelet-derived growth factor (PDGF), transformative growth factor (TGF) and insulin-like growth factor-1 (IGF-1), thus creating a perpetual healing process.

A case reported by Ray et al. (2016) evidenced the use of PRF in a traumatized, necrotic, and immature tooth with incomplete root development of an 11-year-old patient, in whom his left upper central incisor was present with an intrusive dislocation and was not responding to the cold pulp vitality test, or the percussion test. Among the options presented, the treatment of choice was revascularization using the PRF membrane in segments of 3 to 5 mm, which were used to fill the entire canal up to 3 mm below the amelo-cementary junction. After a 36-month follow-up, it was evident that there was a marked improvement in the condition of the traumatized tooth after the use of the PRF. Similarly, Bakhtiar et al. (2017) reported four cases of immature teeth with necrotic pulps that were submitted to RET, in which the entire tissue of the necrotic pulp was removed and then the canal was filled with PRF, after 18 months of follow-up it was possible to notice the resolution of periapical lesions, root development and apical closure in all cases.

Merschi et al. (2021) reported in a series of cases the impact of the use of PRF and L-PRF on immature permanent teeth on about regenerative endodontic procedures. The authors evaluated periapical bone healing (BhP) and additional root development (RD) and after the procedure all patients were called for follow-up of 3, 6, 12, 24 and 36 months. And each session was performed a periapical radiograph to evaluate the state of the tooth. Only 50% of the 14 teeth evaluated with CBCT had complete PBH. In relation to baseline in hard root tissue volume, average root hard tissue thickness and apical area, the control group performed
significantly in favor of RD than the test group. In view of REP-LPRF, it is a viable treatment option to obtain BhP and assist in the RD of necrotic immature permanent teeth. Caution is required when evaluating REP to succeed in this regenerative treatment.

In this context, Ulusoy et al. (2019) described that regenerative endodontic procedures (REPs) using autologous platelet concentrates as scaffolding can improve the biological outcome of treatment. The authors evidenced this fact in a series of cases treating 67 children aged 8 to 11 years with immature necrotic incisors. Therefore, platelet-rich plasma (PRP), platelet-rich fibrin (PRF), platelet pellet (PP) and an induced clot (BC) were divided into 4 groups, and these groups were fractionated to qualify treatment results. They were evaluated using a combined system of clinical and radiographic punctuation, while changes in root dimensions were compared using linear measurements of length and width of the root with image. In the present study, there was no significant difference in the time of onset and post-treatment of positive responses to vitality tests between the groups. However, the PRP, PRF and PP groups had significantly faster initial response times to sensitivity tests than the BC group. Therefore, the lack of apical bleeding in these groups may limit or prevent the healing of these dental elements.

Popowicz et al. (2019) described in their study of 2 cases the use of technology with computerized conical beam tomographic imaging (CBCT), three-dimensional printing technology (3D) and this study shows the advantage of these innovations in endodontic microsurgery. A collagen graft may be another alternative, however, it has been proven that PRF has a beneficial effect on regeneration. In an oral surgery procedure, such as the conservation of an extraction socket, the PRF has been used as an autologous graft with positive results. And with technological advances and its application in various surgical procedures in the medical and dental fields, the guided 3D technique has potential in endodontic microsurgery, especially for difficult areas. And it has been increasingly beneficial to improve and facilitate this type of procedure, this shows that it is not only directed at execution, but also towards a favorable and incredibly positive result in a short period of time.

Zhou et al. (2017) evaluated the simultaneous use of platelet-rich fibrin (PRF) with a blood clot (BC) in RET in relation to periapical healing, root development and structural reinforcement of the tooth. This study aimed to evaluate molars of 3 beagle dogs, were divided into control groups, BC and PRF + BC. The authors pointed out that the increase in root length and thickness in the BC and PRF + BC groups was significantly higher than in the control group, but no significant difference was detected between the 2 experimental groups in relation to periapical healing or root development. And in all groups, it was noticed that there was
histological evidence of cemento-like tissue deposition along the canal wall with bone tissue dispersed in the canal. In this context, the combination of PRF with BC or only BC could improve periapical healing, induce root development and strengthen dental structure. No additional benefit of PRF for BC in RET was found in this study.

5 CONCLUSION

In view of the studies discussed, the PRF proved to be effective in regenerative endodontic treatments, reducing periapical lesions, assisting in root formation and apical closure. Moreover, it is possible to evidence that its performance in endodontics has high potentials, destined both to the intracanal scope and to conducts that require parendodontic interventions such as microsurgeries. On the other hand, among the factors highlighted as obstacles to the use of THE PRF, one can highlight the need for the specific device for centrifugation and obtaining, as well as the accuracy of removing blood from the patient to obtain the material, a factor that can be highlighted as invasive mainly in younger and anxious people, such as children. However, such issues are still denoted as small when compared to the positive points that the insertion of this biomaterial can bring to endodontic therapies. New clinical trials and broader studies are needed to strengthen existing evidence regarding the effectiveness and applicability of PRF in regenerative endodontic procedures.
REFERENCES


