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Benefits of using platelet-rich fibrin in implantology

Julien Adida Ceccon

Dissertação conducente ao **Grau de Mestre** em **Medicina Dentária (Ciclo Integrado)**

—

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Trabalho realizado sob a Orientação de Mestre Lara Coelho

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Eu, acima identificado, declaro ter atuado com absoluta integridade na elaboração deste trabalho, confirmo que em todo o trabalho conducente à sua elaboração não recorri a qualquer forma de falsificação de resultados ou à prática de plágio (ato pelo qual um indivíduo, mesmo por omissão, assume a autoria do trabalho intelectual pertencente a outrem, na sua totalidade ou em partes dele). Mais declaro que todas as frases que retirei de trabalhos anteriores pertencentes a outros autores foram referenciadas ou redigidas com novas palavras, tendo neste caso colocado a citação da fonte bibliográfica.

Scientific Communications (Poster)

Adida J, Coelho L., Os beneficios do uso da fibrina rica em plaquetas na implantologia, Jornadas IUCS-CESPU-2024, 9-10 Abril, Porto (Menção honrosa)*

*in annexes

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RESUMO

Introdução: A falta de dentes é comum e tratável com implantes dentários. Apesar da alta sobrevivência, a odontologia evolui constantemente, e estudos mostram benefícios da aplicação da fibrina rica em plaquetas (PRF) na implantologia.

Objetivos: Investigar sobre a PRF em implantologia e comparar os resultados da sua aplicação na estabilidade do implante e cicatrização.

Materiais e métodos: Realizou-se uma pesquisa bibliográfica na PubMed entre 2001 e 2024; foram selecionados 12 artigos.

Resultados: Dos 9 estudos, 3 demonstraram diferenças significativas no quociente de estabilidade do implante (ISQ) para o grupo PRF. Nenhum dos 4 estudos que avaliaram a profundidade da bolsa peri-implantar mostrou melhorias significativas. 3 dos 5 estudos sobre os níveis de osso crestal encontrarem melhorias significativas com PRF. 6 estudos forneceram dados sobre as taxas de sobrevivência dos implantes, sem análise estatística das diferenças.

Discussão: Alguns estudos sugerem uma maior eficácia em implantes com estabilidade primária ISQ<40 e um impacto mínimo naqueles com ISQ≥70. Outros indicam resultados significativamente melhores do PRF na formação de novo osso à volta dos implantes. Todos os estudos examinados relatam melhorias na cicatrização dos tecidos moles facilitadas pelo PRF com variação na significância estatística refletindo uma interação complexa de fatores de estabilidade biológica e mecânica que influenciam a eficácia global.

Conclusão: Não existem provas suficientes da eficácia do PRF na taxa de sobrevivência e na cicatrização dos tecidos moles. Embora tenha potenciais benefícios para a estabilidade do implante e a osseointegração. Mais estudos são necessários para confirmar a sua eficácia a longo prazo.

Palavras-chaves: *"Dental Implants"*, *"Osseointegration"*, *"Platelet-Rich Plasma"*, *"Blood Platelets"*, *"Bone remodelling"* e *"Wound Healing"*.

ABSTRACT

Introduction: Missing teeth is common and can be solved by placing dental implants. Despite the high survival rate, dentistry is constantly evolving, and studies are emerging that show the benefits of applying platelet-rich fibrin in implantology.

Objectives: Investigate the application of PRF in implantology and compare the results on implant stability, survival rate, and healing.

Materials and methods: A bibliographic search was conducted in PubMed between 2001 and 2024; 12 articles were selected.

Results: 8 of 9 studies demonstrated increased implant stability quotient for the PRF group, but only 3 showed significant differences. 4 studies assessed peri-implant pocket depth, with none showing significant improvements. 5 studies reviewed crestal bone levels, with 3 finding significant improvements in the PRF group. 6 of the 12 studies we reviewed provided explicit data on implant survival rates, with no statistical analysis of differences.

Discussion: Some studies suggest greater efficacy in implants with primary stability ISQ<40 and minimal impact on those with ISQ≥70. Other studies indicate significantly better PRF results, especially in stimulating new bone formation around the implants. All examined studies report enhancements in soft tissue healing around implants facilitated by PRF. However, the statistical significance of these improvements varies across different research, reflecting a complex interplay of biological and mechanical factors influencing the overall efficacy.

Conclusion: There is insufficient evidence to demonstrate the effectiveness of PRF for survival rate and soft tissue healing despite its potential benefits for implant stability and osseointegration. Further well-conducted studies are required to determine its long-term efficacy.

Keywords: *"Dental Implants", "Osseointegration", "Platelet-Rich Plasma", "Blood Platelets", "Bone remodeling", and "Wound Healing".*

CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

PCs	Platelet concentrates
PRP	Platelet-rich plasma
PRF	Platelet-rich fibrin
ISQ	Implant Stability Quotient
PPD	Peri-implant pocket probing depth
CBH	Crestal bone height
CBL	Crestal bone level
T	Study group
C	Control group
RCT	Randomized controlled trial
RFA	Resonance frequency analysis
L-PRF	Leukocyte- and platelet-rich fibrin
A-PRF	Advanced-PRF

1. Introduction

Modern dentistry aims to rehabilitate patients to normal function, speech, health, and aesthetics despite atrophy, disease, or injury to the stomatognathic system. Meeting this objective, dental implants emerge as an optimal choice for individuals with good general oral health who have experienced tooth loss. Those implants are surgically placed into the jawbone to support oral rehabilitations like screw-retained crowns, bridges, or overdentures. Implant dentistry has become a widely used treatment modality. However, the success of dental implants depends on various factors, such as implant design (length and diameter), bone quality, age, surgical technique, and the location of the implant (1).

Despite the advancements in implant technology, implant failure remains a significant concern. Factors that can lead to implant failure include infection, implant lack of instability, low quantity or/and quality of bone, poor oral hygiene, and maintenance (2). Several complications are associated with implant failure, like peri-implantitis, characterized by inflammation of the soft and hard tissues surrounding the implant and loss of supporting bone (3).

There has been a constant search for methods to accelerate new bone formation and improve healing to avoid those complications. Currently, tissue regenerative modalities point toward using concentrates derived from the peripheral blood. Platelet concentrates (PCs), such as platelet-rich plasma (PRP), are autologous bioactive additives with diverse applications, from oral and maxillofacial surgery to plastic surgery and sports medicine. Since their inception in 1954, PCs technologies have evolved significantly, contributing to the regulation of inflammation and acceleration of the healing process (4).

All this evolution has led to the formation of a new kind of fibrin adhesive-concentrated Platelet-rich plasma (cPRP). However, due to legal constraints regarding blood handling protocols, a different type of PC appeared: Platelet-rich fibrin (PRF) (5).

PRF, developed in 2001 by J. Choukroun in France, represents a second-generation PC widely employed for expediting the healing of soft and hard tissues. PRF is a biomaterial derived from blood extracted from a patient sample, part of a PC obtained through centrifugation (6).

Its distinct advantages over the more widely recognized PRP include easy separation and application, cost-effectiveness, and the absence of biochemical modifications such as the need for bovine thrombin or anticoagulant. PRF stands out as a strictly autologous fibrin matrix containing many platelet and leukocyte cytokines (7).

This three-dimensional network, forming a fibrin clot, serves as a cell stimulant, progressively and consistently releasing growth factors and cytokines into the environment. The goal is to stimulate, enhance, and accelerate tissue healing, encompassing mucosa and bone tissues (5).

Numerous indications for the use of PRF have been proposed for surgical procedures in the oral cavity. From extraction socket healing to bone grafting, periodontal surgery, implant placement, pain management, soft tissue healing, peri-implantitis treatment, alveolar ridge preservation, and sinus lift procedures to promote tissue regeneration and accelerate healing (4).

The interest of this work is to assess the extent to which the use of PRF during dental implant placement prevents typical complications by enhancing stability, improving survival rates, and promoting faster healing of hard and soft tissue.

2. Objectives

2.1 General objectives

The objective of the present systematic review is to evaluate the effectiveness of PRF in promoting hard and soft tissue regeneration and accelerating osseointegration in implantology procedures. This will involve comparing the outcomes of implant procedures with and without using PRF as a biomaterial in patients undergoing tooth replacement with a dental implant.

2.2 Specific objectives

To assess the effectiveness of the PRF in implantology, we will study the implant stability quotient (ISQ) at the time of implant placement (primary stability) and at several points during follow-up. We will also measure soft tissue healing through peri-implant pocket probing depth (PPD) and study digital radiographs to determine the amount of bone by measuring the crestal bone height or level (CBH/CBL). Additionally, we will compare the implant survival rate.

3. Materials e methods

3.1 Protocol developed

A protocol was developed following the PRISMA 2020 statement (a reference guide for systematic reviews) to prepare this integrative systematic review (8).

3.2 Research question(s)

To organize the object of study, through structured research questions, the PICO methodology was used, giving rise to the following questions:

1) What is the impact of PRF on the stability of the implant?
2) How do implant survival rates and complications, such as infection, inflammation, or other adverse events, differ between dental implant procedures with and without PRF?
3) To what extent does the utilization of PRF influence the speed of soft and hard tissue healing around dental implants compared to procedures without PRF?
4) How does the CBL change over time with PRF compared to procedures without PRF in dental implant cases?

3.3 PICO question criteria:

The criteria for the PICO question were as follows:

Table 1 - PICO

Population (P)	Patients requiring a dental implant
Intervention (I)	Placement of a dental implant
Comparison (C)	Study group (T): Placement of a dental implant with PRF Control group (C):Placement of a dental implant without PRF
Outcome (O)	Implant stability, implant survival rate, soft tissue healing, bone healing

3.4 Search strategy

A literature review was conducted in the Pub MED/Medline database, including articles published from 1 January 2001 to 1 January 2024.

Clinical case studies from a dental practice using the PRF technique in implantology.

3.5 Keywords

The literature search was carried out using the following terms:

MeSH Terms:

"Dental Implants"; "Osseointegration"; "Dental Implantation"; "Bone-Implant Interface"; "Platelet-Rich Plasma"; "Blood Platelets"; "Bone remodeling"; "Alveolar Bone Loss"; "Resonance frequency analysis"; "Wound Healing"; "Postoperative Period"

Free Terms:

"Dental Implants"; "Peri-implant Endosseous Healing"; "Osseointegration"; "Dental Implantation"; "Dental Implant Therapy"; "Teeth implant"; "Implant surgery"; "Surgical dental prosthesis"; "Platelet-Rich Plasma"; "Blood Platelets"; "L-PRF"; "Leukocyte and Platelet Rich Fibrin"; "Fibrin Glue"; "Fibrin Adhesive"; "Choukroun"; "Platelet Rich Fibrin"; "PRF"; "A-PRF"; "I-PRF"; "C-PRF" ;"T-PRF"; "Bone remodeling"; "Bone Regeneration"; "Bone Turnover"; "Alveolar Bone Loss"; "Periodontal Bone Loss"; "Periodontal Resorption"; "Resonance frequency analysis"; "Implant stability"; "Wound Healing"; "Postoperative Period"; "Healing"; "Tissue regeneration"; "Periimplantitis"

3.6 Inclusion criteria

- Studies in English, French, and Portuguese
- Studies only on human
- Minimum 10 patients
- The surgical protocol of each experimental group had to include the use of PRF at the time of implant placement at the implant site.
- Each study had to include a control group whose surgical protocol did not include PRF.

- A minimum follow-up of 4 weeks after dental implant placement
- Studies between 1 January 2001 and 1 January 2024.
- Type of studies: Clinical Trial; Randomized controlled trial (RCT)

3.7 Exclusion criteria

The following criteria were excluded from the study:

- Case Report, Case Series, Cohort Studies, and Case-control Studies
- Animal studies in vivo and in vitro
- Studies of PRF without implant placement
- PCs other than PRF
- Studies without a control group
- Studies without detailed follow-up
- Studies in which implant stability is assessed by means other than resonance frequency analysis (RFA)

3.8 Sample data extraction

A table of results was created to summarize the collected information.

This table includes the author, study design, objective of the study, sample size (detailing the number of patients and implants), type of intervention, evaluation methods or parameters studied, follow-up period, and results (implant stability, implant survival rate, soft tissue healing, bone healing).

3.9 Assessment of methodological quality

To guarantee the quality of the studies, we used the Jadad scale, which consists of answering five questions. A positive answer receives one point, and a negative one receives zero points. Ultimately, each study will be rated between 0 and 5, where 0 corresponds to methodologically inferior research and 5 to very rigorous one (9).

4. Results

4.1 Search results

The search for studies in the Pubmed database was carried out by combining keywords with Boolean operators and is summarized in the following table:

Table 2 - Search expression in Pubmed

N°		Results PubMed
1	"Dental Implants"[Mesh] OR "Osseointegration"[Mesh] OR "Dental Implantation"[Mesh] OR "Bone-Implant Interface"[Mesh] OR "Dental Implants" OR "Peri-implant Endosseous Healing" OR "Osseointegration" OR "Dental Implantation" OR "Dental Implant Therapy" OR "Teeth implant" OR "Implant surgery" OR "Surgical dental prosthesis" **AND**	
2	"Platelet-Rich Plasma"[Mesh] OR "Blood Platelets"[Mesh] OR "Platelet-Rich Plasma" OR "Blood Platelets" OR "L-PRF" OR "Leukocyte and Platelet Rich Fibrin" OR "Fibrin Glue" OR "Fibrin Adhesive" OR "Choukroun" OR "Platelet Rich Fibrin" OR "PRF" OR "A-PRF" OR "I-PRF" OR "C-PRF" OR "T-PRF" **AND**	
3	"Bone remodeling"[Mesh] OR "Alveolar Bone Loss"[Mesh] OR "Resonance frequency analysis"[Mesh] OR "Wound Healing" [Mesh] OR "Postoperative Period" [Mesh] "Bone remodeling" OR "Bone Regeneration" OR "Bone Turnover" OR "Alveolar Bone Loss" OR "Periodontal Bone Loss" OR "Periodontal Resorption" OR "Resonance frequency analysis" OR "Implant stability" "Wound Healing" [Mesh] OR "Postoperative Period" [Mesh] OR "Healing" OR "Tissue regeneration" OR "Periimplantitis"	
		1123

This search initially identified 1,123 studies. Records marked as ineligible by automation tools totaled 104, and an additional 656 were removed for various reasons before screening. This left 363 articles for title and abstract review. After this screening, 338 articles were excluded, leaving 31 for a full reading. Of these, articles were further excluded based on the following criteria: lack of a control group (8 articles), sample size of fewer than 10 patients (5 articles), absence of implant placement (4 articles), and lack of detailed follow-up (3 articles). One article has been found in the secondary bibliography.

Ultimately, 12 studies met all criteria according to the PRISMA flowchart (figure 1) and were included in the review.

Some studies and systematic reviews found in the secondary bibliography were added to enrich the discussion.

4.2 Flowchart

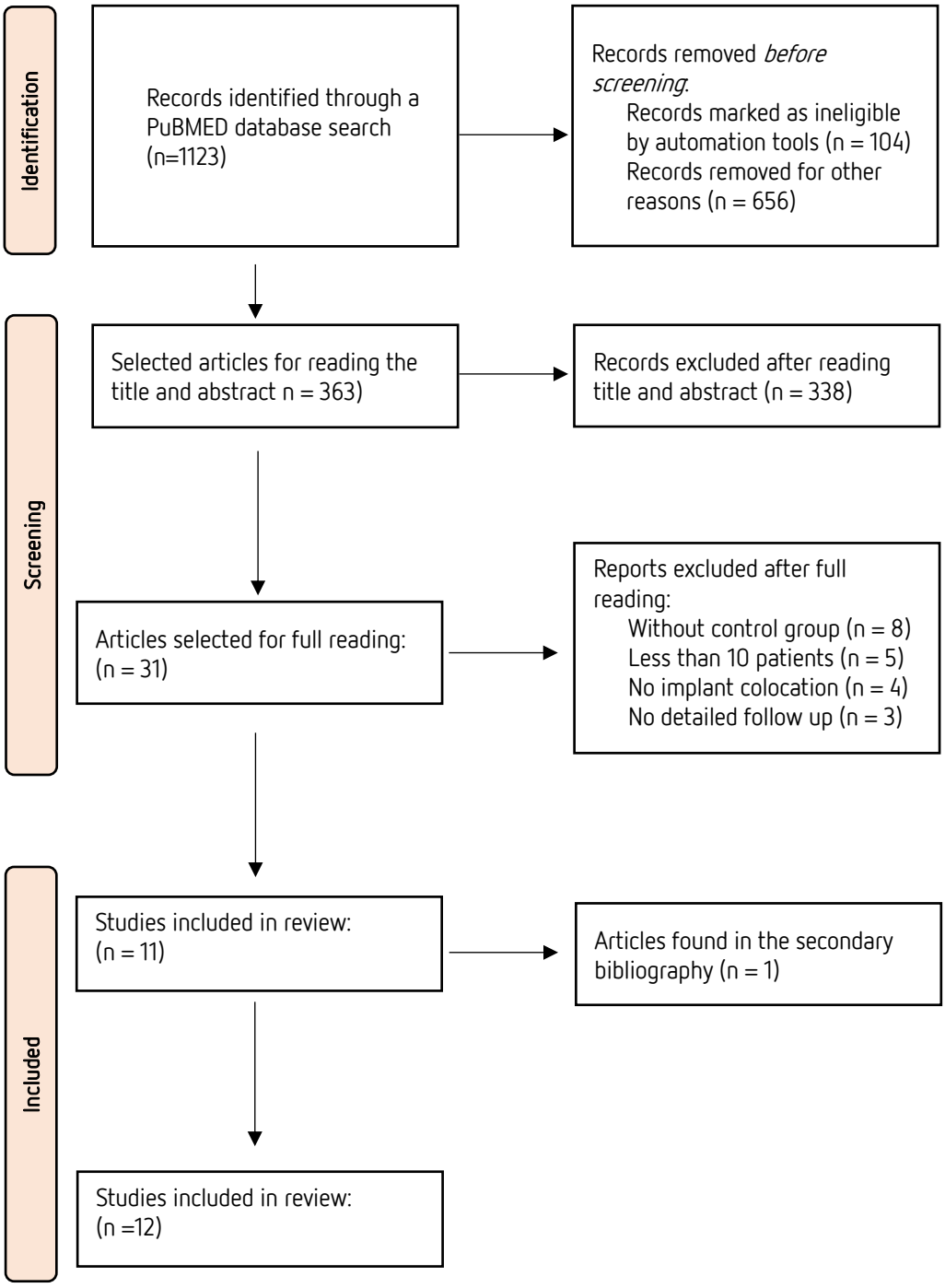

Figure 1 - Research flowchart

4.3 Sample characterization for study quality

The 12 RCTs were evaluated using the Jadad scale (9) to assess the methodological quality of the source used.

Table 3 shows the evaluation according to the Jadad scale:

Table 3 - Jadad scale

Author	Study described as randomized?	Adequate randomization method described?	Double-blind study?	Is the concealment method adequate?	Descriptions of exclusions or withdrawals?	Total
Hussein et al., 2017 (10)	1	1	0	0	1	3
Diana et al., 2018 (11)	1	1	0	0	1	3
Shetye et al., 2022 (12)	1	0	0	0	1	2
Alhussaini et al., 2019 (13)	0	0	0	0	1	1
Cheruvu et al., 2023 (14)	1	1	1	1	1	5
Öncü et al., 2015 (15)	1	1	1	1	1	5
Tabrizi et al., 2018 (16)	1	1	1	1	1	5
Boora et al., 2015 (17)	1	1	0	0	1	3
Sharma et al., 2022 (18)	1	1	0	0	1	3
Naeimi Darestani et al., 2023 (19)	1	1	0	1	1	4
Güvenç et al., 2022 (20)	1	1	0	1	1	4
Fernandes et al., 2021 (21)	1	1	1	1	1	5

The results, illustrated in Table 3, show that the selected studies score between 1 and 5 on the Jadad scale, with an average of 3,9.

4.4 Results

Table 4 - Table of results

Author	Study design	Objective of the study	Distribution of the patient / Total Age range	Intervention	Evaluation methods / Parameters studied	Follow-up	Results (quantitative data or qualitative findings)	
Hussein et al., 2017 (10)	RCT	Evaluate the effect of PRF on stability of dental implants	C: 29 implants T: 29 implants Total: 19 patients 28 – 66 years	C: implant without PRF T: implant + PRF	- Implant stability: RFA using Osstell™ ISQ - Survival rate	**ISQ**	control group	study group
						t_0 - primary stability	75.52 ± 4.93	73.15 ± 8.41
						t4w	68.52 ± 8.84	68.1 ± 7.52
						t8w	72.48 ± 6.07	71.75 ± 8.08
						t12w	75.04 ± 6.16	74.46 ± 8.06
						no significative difference		
						Survival rate	control group	study group
							93.1%	100%
Diana et al., 2018 (11)	RCT	Evaluate the effect of PRF on stability of immediate dental implants, amount of regenerated bone and crestal bone resorption	C: 20 implants T: 21 implants Total: 29 patients Mean age: 28,5 years	C: no augmentation T: autologous PRF peri-implant region	- Implant stability: RFA using Osstell™ ISQ - Survival rate - PPD, measured in mm using a periodontal probe - Digital radiographs for the assessment of CBH (mm)	**ISQ**	control group	study group
						t_0	60.61 ± 11.49	56.58 ± 18.81
						t3m	70.06 ± 8.69	71.32 ± 7.82
						no significative difference		
						Survival rate	control group	study group
							100%	90.5%
						Peri-implant pocket depth	control group	study group
						t_0	1.50 ± 0.49	1.63 ± 0.60
						t3m	1.80 ± 0.71	1.82 ± 0.58
						t1y	2.60 ± 0.68	2.01 ± 0.62
						no significative difference		

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>
<table>
<tr><td>CBH (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t_0</td><td>1.54 ± 0.99</td><td>1.48 ± 1.06</td><td>1.64 ± 1.47</td><td>1.39± 1.48</td></tr>
<tr><td>t1m</td><td>0.63 ± 1.19</td><td>0.5 ± 1.02</td><td>0.69 ± 1.57</td><td>0.52± 1.25</td></tr>
<tr><td>t3m</td><td>0.62 ±0.87</td><td>0.54± 0.86</td><td>1.18 ± 1.26</td><td>0.9 ±1.32</td></tr>
<tr><td>t6m</td><td>0.96 ±0.88</td><td>0.94 ±0.10</td><td>1.18 ± 1.28</td><td>1.17 ±1.19</td></tr>
<tr><td>t1y</td><td>0.85± 0.76</td><td>0.92± 0.34</td><td>1.17 ± 1.14</td><td>1.15 ±0.96</td></tr>
<tr><td colspan="5">no significative difference</td></tr>
</table>
</td></tr>
<tr><td>Shetye et al., 2022
(12)</td><td>Prospective clinical study</td><td>Evaluate the effect of Advanced-PRF (A-PRF) on tissues around implants in the maxillary anterior region</td><td>C: 10 implants
T: 10 implants

Total: 20 patients

18 – 62 years</td><td>C: Endosseous implant placement without A-PRF
T: Endosseous implant placement with A-PRF</td><td>- Implant stability: RFA using Periotest ISQ
- PPD, measured in mm using a periodontal probe
- Digital radiographs for the assessment of CBH</td><td>
<table>
<tr><td>ISQ</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td>t_0 - primary stability</td><td colspan="2">7.90 ± 0.88</td><td colspan="2">7.10 ± 1.10</td></tr>
<tr><td>t2w</td><td colspan="2">7.10 ± 0.88</td><td colspan="2">6.20 ± 1.03</td></tr>
<tr><td>t2m</td><td colspan="2">6.80 ± 0.92*</td><td colspan="2">5.60 ± 1.07</td></tr>
<tr><td>t6m</td><td colspan="2">5.50 ± 1.65</td><td colspan="2">4.50 ± 1.84</td></tr>
<tr><td>t12m</td><td colspan="2">4.60 ± 2.01</td><td colspan="2">3.90 ± 1.79</td></tr>
<tr><td colspan="5">*significative difference</td></tr>
<tr><td>PPD (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t_0</td><td>1.95 ± 0.60</td><td>1.90 ± 0.39</td><td>1.30 ± 0.48</td><td>1.65 ± 0.47</td></tr>
<tr><td>t2w</td><td>1.90 ± 0.61</td><td>2.00 ±0.58</td><td>1.70 ± 0.48</td><td>2.05 ± 0.44</td></tr>
<tr><td>t2m</td><td>2.05 ±0.60</td><td>2.35 ± 0.82</td><td>2.05 ± 0.55</td><td>2.25 ± 0.79</td></tr>
<tr><td>t6m</td><td>2.05 ± 0.98</td><td>2.50 ± 0.85</td><td>2.10 ± 0.84</td><td>2.25 ± 0.79</td></tr>
<tr><td>t1y</td><td>2.40 ± 0.91</td><td>2.85 ± 0.85</td><td>2.45 ± 0.72</td><td>2.45 ± 0.80</td></tr>
<tr><td colspan="5">no significative difference</td></tr>
<tr><td>CBH (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t_0</td><td>0.86 ±0.84</td><td>1.15 ± 0.82</td><td>1.26 ±0.96</td><td>1.34 ± 0.86</td></tr>
<tr><td>t2w</td><td>0.94 ± 0.77</td><td>1.26 ± 0.75</td><td>1.36 ±0.91</td><td>1.45 ± 0.84</td></tr>
<tr><td>t2m</td><td>1.04 ± 0.83</td><td>1.34 ± 0.79</td><td>1.45 ± 0.91</td><td>1.54 ± 0.80</td></tr>
<tr><td>t6m</td><td>1.23 ± 0.75</td><td>1.57 ± 0.76</td><td>1.68 ±0.85</td><td>1.72 ± 0.73</td></tr>
<tr><td>t1y</td><td>1.48 ± 0.75</td><td>1.75 ± 0.75</td><td>1.90 ±0.89</td><td>1.94 ± 0.73</td></tr>
<tr><td colspan="5">no significative difference</td></tr>
</table>
</td></tr>
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Alhussaini et al., 2019 (13)	RCT	Evaluate the effect of L-PRF on stability of dental implants	C: 51 implants T: 27 implants Total: 49 patients 25–66 years	C: implant without L-PRF T: implant with L-PRF	- Implant stability: RFA using Osstell™ ISQ	**ISQ**	control group	study group
						t_0 - primary stability	70.5 ± 7.8	73.1 ± 8.4
						t6w	67.2 ± 8.2	71.0 ± 7.3*
						t12w	70.8 ± 8.3	74.5 ± 8.1*
						*significative differences		
Cheruvu et al., 2023 (14)	RCT	Evaluate the effect of PRF on soft tissue healing and the CBL around non-submerged dental implants	C: 17 implants T: 18 implants Total: 35 patients 20–60 years	C: non-submerged implants without PRF T: non-submerged implants with a PRF membrane	- Survival rate - Radiographic measure of the CBL	**Survival rate**	control group	study group
							90%	95%
						CBL (mm)	control group	study group
						t3m	1.34 ±0.41	1.10 ±0.80*
						t6m	1.88 ±0.64	1.53 ±0.38*
						*significative differences		
Öncü et al., 2015 (15)	RCT	Evaluate the effects of PRF application on implant osseointegration in early healing	C 10 patients T: 10 patients Total: 64 implants Mean age 44.2 ± 12.5 years	C: adjacent implant without PRF T: implant with PRF membrane	- Implant stability: RFA using Osstell™ ISQ	**ISQ**	control group	study group
						t_0 - primary stability	62.67 ±13.61	59.39 ±15.88
						t1w	60.03 ±12.2	69.29 ±10.51*
						t4w	70.49 ±7.74	77.19 ±6.06*
						*significative differences		
Tabrizi et al., 2018 (16)	RCT	Evaluate the effect of PRF on stability of dental implants	C: 20 implants T: 20 implants Total: 40 patients Mean age 39.60 ± 6.74 years	C: implant without PRF T: implant + PRF	- Implant stability: RFA using Osstell™ ISQ	**ISQ**	control group	study group
						t2w	58.25± 3.64	60.60± 3.42*
						t4w	67.15 ± 4.33	70.30 ± 3.36*
						t6w	78.45 ± 3.36	76.15 ± 2.94*
						*significative differences		

<table>
<tr>
<td>Boora et al., 2015
(17)</td>
<td>RCT</td>
<td>Evaluate the effect of L-PRF on peri-implant tissue response</td>
<td>C: 10 implants
T: 10 implants

Total: 20 patients

18-33 years</td>
<td>C: implant without PRF
T: implant + L-PRF</td>
<td>- Survival rate

Clinical and radiographic assessment:
- PPD measured in mm.
- Digital radiographs for the assessment of CBL in mm</td>
<td>
<table>
<tr><td>Survival rate</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td colspan="2">100%</td><td colspan="2">100%</td></tr>
<tr><td>CBL (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t_0-t1m</td><td>0.3±0.16</td><td>0.3±0.18</td><td>0.13±0.04*</td><td>0.15±0.04*</td></tr>
<tr><td>t_0-t3m</td><td>0.57±0.22</td><td>0.65±0.28</td><td>0.25±0.06*</td><td>0.27±0.07*</td></tr>
<tr><td colspan="5">*significative differences</td></tr>
<tr><td>PPD (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t1m</td><td>5.3±0.6749</td><td>5.1±0.8755</td><td>5±0.8164</td><td>5.1±0.7378</td></tr>
<tr><td>t3m</td><td>3.1±0.3162</td><td>3.8±0.7888</td><td>3.05±1.11</td><td>3.65±0.818</td></tr>
<tr><td colspan="5">No significative difference</td></tr>
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<tr>
<td>Sharma et al., 2022

(18)</td>
<td>RCT</td>
<td>Evaluate the effect of PRF on soft tissue integrity and crestal bone changes clinically and radiographically</td>
<td>C: 10 implants
T: 10 implants

Total: 20 patients

21-55 years</td>
<td>C: implant without PRF
T: implant + PRF</td>
<td>Clinical and radiographic assessment:
- PPD measured in mm.
- Digital radiographs for the assessment of CBL in mm</td>
<td>
<table>
<tr><td>PPD (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td>t_0 - primary stability</td><td colspan="2">1.8±0.36</td><td colspan="2">1.48±0.2*</td></tr>
<tr><td>t6m</td><td colspan="2">1.8±0.38</td><td colspan="2">1.45±0.4*</td></tr>
<tr><td>t9m</td><td colspan="2">1.8±0.39</td><td colspan="2">1.38±0.3*</td></tr>
<tr><td colspan="5">*significative differences</td></tr>
<tr><td>CBL (mm)</td><td colspan="2">control group</td><td colspan="2">study group</td></tr>
<tr><td></td><td>mesial</td><td>distal</td><td>mesial</td><td>distal</td></tr>
<tr><td>t_0 - primary stability</td><td>0.28±0.22</td><td>0.19±0.15</td><td>0.10±0.05*</td><td>0.15±0.11</td></tr>
<tr><td>t6m</td><td>0.42±0.34</td><td>0.32±0.22</td><td>0.11±0.07*</td><td>0.08±0.09*</td></tr>
<tr><td>t9m</td><td>0.55±0.47</td><td>0.34±0.19</td><td>0.17±0.16*</td><td>0.11±0.08*</td></tr>
<tr><td colspan="5">* significative differences</td></tr>
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Naeimi Darestani et al., 2023 (19)	RCT	Evaluate the effects of -PRF on implant stability and alterations in the marginal bone surrounding posterior maxillary implants	C: 14 implants T: 14 implants Total: 14 patients Mean age: 49 years	C: implant without PRF T: implant + L-PRF	- Implant stability: RFA using Osstell™ ISQ	**ISQ**	control group	study group
						t_0 - primary stability	61.3 ± 13.04	62.0 ± 10.39
						t1w	59.9 ± 11.56	59.5 ± 8.83
						t2w	58.4 ± 11.78	58.1 ± 11.30
						t4w	60.8 ± 7.07	58.6 ± 10.04
						t6w	61.7 ± 10.25	61.7 ± 10.68
						t8w	67.9 ± 8.70	65.9 ± 8.89
						t12w	70.4 ± 5.29	70.2 ± 7.21
						no significative difference		
Güvenç et al., 2022 (20)	RCT	Evaluate the effect of injectable-PRF on stability of dental implants	40 implants Total: 15 patients Distribution not specified 25-67 years	C: implant without PRF T: implant + I-PRF	- Implant stability: RFA using Osstell™ ISQ - Survival rate	**ISQ**	control group	study group
						t_0 - primary stability	74,67 ± 8.92*	72.48 ± 8.52
						t1w	72.08 ± 10.11	74.22 ± 8.30*
						t2w	72.37 ± 8.04	75.02 ± 7.97*
						t4w	72.66 ± 8.27	76.85 ± 4.87*
						*significative differences		
						Survival rate	control group	study group
							100%	100%
Fernandes et al., 2021 (21)	RCT	Evaluate the effect of liquid -PRF on osseointegration, stability and rehabilitation period	C: 15 implants T: 15 implants Total: 15 patients 21-60 years	C: implant without PRF T: implant + L-PRF	- Implant stability: RFA using Osstell™ ISQ - Survival rate	**ISQ**	control group	study group
						t2w	64.87 ± 6.01	67.36 ± 7.21
						tf (after the placement of the crown)	67.67 ± 6.13	70.14 ± 6.40
						no significative difference		
						Survival rate	control group	study group
							93.3%	86.6%

5. Discussion

5.1 Implant stability

Ensuring implant stability is paramount for achieving sustained success following implant placement.

Over the years, various techniques for assessing implant stability have emerged. The most used are RFA, tactile feeling, torque test, and percussion test. However, RFA is the only objective, non-invasive, and repeatable way to measure the ISQ (22–24). This is why the present systematic review excludes all the studies that do not use an RFA system to measure implant stability.

This method involves attaching a metal peg, equipped with a magnet at the top, to the implant. Subsequently, magnetic pulses—alternating sine waves of uniform amplitude—are transmitted to the peg, inducing vibrations. These vibrations steadily increase in pitch until the implant reaches resonance, signified by a peak in frequency response. The resonant frequency, thus obtained, correlates with the stability of the implant, with higher frequencies indicative of greater stability. This technique provides valuable quantitative data for evaluating osseointegration and guiding treatment decisions (23).

Implant stability is essential for the long-term success of implant placement. It comprises two main components: mechanical (primary) stability and biological (secondary) stability. At the time of insertion, mechanical stability is achieved as the implant functions akin to a screw, firmly anchored in the bone through compression. This primary stability relies on the surrounding bone tightly grasping the implant. However, in the weeks following implant placement, the dynamics shift. While new bone formation occurs in direct contact with the implant surface, the older bone may undergo resorption. This process leads to a temporary decrease in total stability as the implant adjusts to its osseous environment (22–24).

Over time, as osseointegration progresses, the newly formed bone integrates with the implant surface, contributing to biological stability. This secondary stability becomes the predominant factor influencing overall implant stability, surpassing the initial mechanical stability achieved during insertion (23).

Variability in stability enhancement

Our systematic review analyzed 9 articles that assessed the evolution of implant stability with and without PRF (10–13,15,16,19–21). Of these, 8 studies demonstrated an increase in the ISQ (10,11,13,15,16,19–21) for the PRF group, but only 3 (15,16,20) had statistically significant differences. The other 5 articles indicate changes without significant differences (10,11,13,19,21). A single article (12) shows mean implant stability at 2 months significantly higher among the control group than the PRF group.

Studies (15,16) demonstrated a significant increase in implant stability during the early healing period (within the first month) with the application of PRF. These findings suggest that the straightforward application of this material may facilitate faster osseointegration. What makes these studies particularly noteworthy is that they show the same results despite examining different implant placement sites: the posterior and anterior maxilla.

These results were also confirmed in another study (20) using i-PRF and with measurements taken every week for a month. In this study, the second and fourth weeks showed the highest average ISQ values, and it was also statistically significant.

One study (12) reported a significant difference in mean implant stability between the control and study groups at 2 months, with the control group exhibiting higher stability compared to the PRF group. This suggests that PRF may not consistently enhance stability compared to controls. This inconsistency could be attributed to several factors. First, the individual variability in response to PRF among patients could play a critical role. Some patients might respond more favorably to PRF due to their intrinsic healing capabilities, while others may not exhibit significant improvements. In this study, the average age of the patients was relatively young, suggesting generally good bone quality, which could inherently affect outcomes—35.4 years old in the control group and 22.2 years old in the study group. Second, the technique and protocol used for applying A-PRF during the implant procedure might influence the outcomes. This study is unique in our systematic review in that it uses A-PRF, differing from other forms of PRF in its preparation and application. A-PRF involves a specific protocol that might not have been optimized in this study setting, potentially affecting its efficacy. Furthermore, the study design and duration

of follow-up could also impact the observed effects of PRF on implant stability. These elements together suggest that while PRF has potential benefits, its effectiveness in enhancing implant stability may not be universally applicable and could depend on a multitude of factors.

Three studies (11,13,19) show a significant increase in implant stability in both the study and the control group several weeks after placement. Another set of studies (10,21) demonstrates that the study group experienced a lesser decline in stability compared to the control group, particularly during the initial phases of healing, notably at the fourth-week mark. Nevertheless, with an absence of a significant disparity in stability between the groups, we could have doubts regarding the role of PRF in immediate implants with sufficient primary stability.

Role of Primary Stability

To understand these results, it is essential to know that previous research (22) has highlighted a higher incidence of implant failure in cases where primary stability values fall below 44, underscoring the importance of measures to bolster implant stability in such scenarios. Therefore, in the studies that did not demonstrate significative differences as the one of Diana et al., 2018 (11), a cut-off ISQ value of 40 was used to identify implants at risk of failure at the time of fixture placement. Eight implants, six in the study group and two in the control group exhibited primary stability below this threshold. Among the six implants in the study group treated with PRF (with a mean primary stability of 27.8 ISQ), four attained sufficient secondary stability at the three-month mark (mean ISQ of 63.8), suggesting a localized effect of PRF in stimulating new bone formation around the implants. Comparable findings were also reported by Oncu et al. (15).

Moreover, in studies like the one conducted by Hussein et al., 2017 (10), the average ISQ at surgery for the control group was 75.52, and for the study group was 73.15, indicating a high primary stability that was 25% higher than the results obtained by other studies that are showing significant differences (15,16). Thus, the secondary stability will be high on most occasions. Therefore, no statistical difference between primary and secondary stability will be measured.

This could lead us to the conclusion that PRF did not improve implant stability or bone gain when there was adequate primary stability (ISQ >60) in immediate implants. PRF can be used as a filling material in implants with a primary stability range of 30–60 ISQ, which may enhance osseous regeneration and increase the success rate.

Thus, the present systematic review findings suggest that PRF benefits the secondary stability of implants but not the primary stability.

Timing and duration of stability enhancement

In a study conducted by He et al. (25) using rats, PRF was found to gradually release autologous growth factors, exhibiting a more potent and enduring impact on the differentiation and proliferation of osteoblasts compared to PRP in vitro. Notably, PRF demonstrated peak release of Transforming Growth Factor-β1 (TGF-β1) at day 14 and Platelet-Derived Growth Factor-AB (PDGF-AB) at day 7, which further supports the previously obtained results.

Moreover, PRF was observed to elevate the concentration of PDGF, exerting a robust chemotactic effect on osteoblasts and other connective tissue cells. Additionally, PRF displayed the ability to mobilize mesenchymal cells during bone formation and remodeling processes. The action of PDGF on bone resorption was noted to occur through the up-regulation of collagen transcription and increased expression of interleukin 6 in osteoblasts (25).

Methodological considerations

Some articles (10,19,21) noted that reliance solely on RFA may only partially capture the effects of PRF, suggesting the need for more comprehensive assessment methods. According to Naeimi Darestani et al. (9), precise measurement of these parameters can only be achieved through histological examination of tissue samples. Consequently, it is not feasible to conclusively ascertain the type of healing, timing, and process of osseointegration around the implant. On the other hand, the clinical manifestation of the healing and ossification around the implant usually appears as the stiffness of the bone-implant contact, which can be evaluated using RFA. There is even a correlation between ISQ values and histological results.

In another study (13), the results indicated that while the stability of implants with PRF showed a higher ISQ than that of the control group 12 weeks after dental implant insertion (3rd reading), this difference was not found to be statistically significant. This lack of significance may be attributed to factors such as the time and speed of centrifugation.

We must also emphasize that the duration of follow-up can impact the results presented by the studies. It is noteworthy that the three (15,16,20) studies showing an improvement in stability with significant differences have relatively short follow-up periods (between 4 and 6 weeks).

That's why these results may require more definitive examination methods at the histological level, including a precise radiographical examination for assessing osseointegration along RFA.

5.2 Peri implant probing depth

Importance of the PPD

PPD is a critical measurement used to assess the health of the tissues surrounding dental implants. This measurement helps in detecting peri-implant diseases (2). Peri-implant probing is performed using a periodontal probe, which measures the depth of the gum pocket around the implant. A healthy implant typically exhibits shallow probing depths without bleeding, indicating that the surrounding tissues are intact and not inflamed. In this systematic review, we choose to use this criterion because, in the evaluation of peri-implant tissue health, probing depth serves as an important diagnostic parameter. To have a reference, the PPBD should not exceed 5 mm for peri-implant health to provide a direct indication of the tissue's structural integrity around dental implants. According to Renvert et al. (26), increased PPD, particularly when combined with symptoms such as bleeding on probing, can signal the onset of peri-implant diseases like mucositis and peri-implantitis, which can lead to bone loss and implant failure if not addressed promptly. Regular monitoring of PPD is essential for early detection and management of peri-implant diseases, thereby enhancing the longevity and success of dental implants (3). Stabilizing or reducing PPD in the context of PRF application could demonstrate its efficacy in improving tissue integration and mitigating inflammatory responses. Therefore, regular monitoring of

PPD post-PRF treatment could be pivotal in validating its benefits in promoting peri-implant tissue health and in preventing the progression of peri-implant diseases.

Variability in the results

The assessment across four studies reveals diverse outcomes. Even if three of the studies (11,12,17) did not demonstrate significant differences in PPD between implants placed with and without PRF, suggesting that PRF may not significantly alter this parameter in certain contexts. It remains important to point out that in these studies the results of the test group (with PRF) are always much better than those of the control group. For example, after a one-year follow-up, Diana et al. (11) suggest a positive trend in the group where PRF is utilized, reporting 2.01mm ± 0.62, compared to 2.60mm ± 0.68 in the control group.

Boora et. Al (17) also shows a positive trend, but the study was carried out with a too-short follow-up (PPD at 1 and 3 months). Indeed, extending the follow-up period in the study by Boora et al. could potentially provide more comprehensive insights into the long-term effects of PRF on PPD. Longer-term assessments could capture the full scope of the impact of PRF on tissue integration and maturation, which might not be fully apparent within the first three months post-implantation. In the initial months following implant placement, the biological processes are primarily focused on healing and inflammation control. The gradual release of growth factors from PRF, which is intended to enhance tissue regeneration and angiogenesis, might manifest more significantly after these initial phases. Throughout 6 to 9 months, or even up to a year, the benefits of PRF in promoting a more robust integration of the implant with the surrounding tissues could become more evident (27). This extended timeline would allow for the observation of not just immediate healing effects but also the long-term stability and health of peri-implant tissues, potentially leading to a clearer understanding of the role of PRF in enhancing the success of dental implants.

In contrast, one (18) documented a statistically significant reduction in PPD over time in the PRF group compared to the control group, indicating its potential benefits in enhancing peri-implant tissue health. From the baseline, the PPD were statistically different between the test (PRF) and control groups. The test group showed an average PPD of 1.48 mm, which was significantly lower than the 1.8 mm observed in the control group ($p = 0.02$). This suggests that even at the outset, the condition of the soft tissue in terms of its integration

and initial healing around the implant was better in the study group. Throughout the study, at six- and nine-months post-implantation, the PPD in the PRF group did not show a significant change, remaining stable at 1.45 mm and 1.38 mm, respectively. In contrast, the control group maintained deeper PPD of around 1.8 mm throughout the same periods. These differences between the groups at six and nine months were statistically significant ($p = 0.04$ at both time points), indicating sustained benefits in maintaining shallower PPD. Notably, the PPD remained relatively stable in the PRF group throughout the study duration, suggesting that PRF may play a protective role in maintaining peri-implant tissue health.

In a study (28) published in the Pan African Medical Journal, the authors explore the utilization of PRF as a regenerative treatment for peri-implantitis. The case study presented within the article demonstrates how PRF membranes were successfully used to cover exposed implant threads, significantly improving peri-implant tissue health, and increasing keratinized mucosa. The findings suggest that PRF not only enhances healing by stabilizing the implant environment but also mitigates inflammatory responses. This innovative approach highlights its potential to act as a cost-effective, biologically compatible treatment option in the management of peri-implant complications. The authors advocate for further research to validate the efficacy of PRF and to standardize its application in clinical settings.

5.3 Crestal bone level change

Crestal Bone Dynamics

Crestal bone changes are an important consideration in dental implantology, mainly because they impact the long-term stability and success of dental implants (3). Following implant placement, a physiological process known as remodeling occurs, in which the crestal bone around the implant undergoes both resorption and regeneration.

Initially, there might be a slight loss of bone primarily due to the surgical trauma and the establishment of a new biological width. This is typically observed within the first year after surgery and is considered normal to some extent. However, the magnitude of these changes can vary based on several factors, including the implant design, the surgical technique employed, the quality and quantity of the patient's bone, and the loading conditions post-implantation (2). Additionally, post-surgical factors such as the loading protocol (immediate

vs. delayed loading) and the type of prosthetic restoration can also impact crestal bone stability. Immediate loading of implants has become more common due to patient demand for rapid restoration. Still, careful case selection is required to minimize the risk of excessive bone loss due to premature loading forces.

Long-term studies suggest that maintaining crestal bone stability is crucial for preventing peri-implant diseases and ensuring the functional longevity of the implant. That's why one of the primary objectives of this systematic review is to investigate the extent to which the use of PRF can mitigate crestal bone loss following dental implant placement. This study seeks to evaluate whether incorporating PRF into the implantation process enhances bone preservation at the crestal level and can effectively reduce the typical bone resorption observed post-implantation, thus potentially improving the overall outcomes of dental implant surgeries.

Positive results on CBL

We reviewed five articles (11,12,14,17,18) that assessed CBL or CBH through radiographic evaluations and specifically examined the impact of PRF. While all five articles demonstrated positive trends favoring the PRF group, only three of these studies (14,17,18) reported statistically significant differences.

Two studies (11,12) report no statistically significant differences in CBH between the PRF and control groups across multiple time points. Diana et al. (11,12) conducted a comprehensive assessment over multiple time points—immediately after implant placement, and at 1, 3, 6 months, and 1 year. This longitudinal approach allowed for a detailed observation of CBH changes over time. Despite this detailed timeline, the study found only slight improvements in CBH in the PRF group, which were not statistically significant. This outcome suggests that while PRF may support some level of bone maintenance or enhancement, its effect is not robust enough to achieve statistical significance under the conditions of this study. The initial decrease in CBH followed by a gradual increase in the PRF and control groups suggests a general trend of bone recovery post-implantation, in which PRF does not significantly enhance beyond the natural healing process observed in the control group. Similarly, Shetye et al. (12) found minor differences

in CBH at 1 year, again indicating no significant benefit from PRF in maintaining or improving CBH.

Conversely, 3 other studies present more promising outcomes with the use of PRF. Cheruvu et al. (14) observed a statistically significant decrease in bone resorption with PRF use at both 3 and 6 months, suggesting an effective role of PRF in preserving CBH. This finding aligns with the observations of Boora et al. (17), who noted a significant reduction in crestal bone loss within the first three months post-implantation in the PRF group, highlighting the protective effects of PRF against early bone loss.

Sharma et al. (18) further support the beneficial effects of PRF, documenting significant preservation of crestal bone in the PRF group compared to controls over six to nine months. This indicates a long-term advantage of PRF in maintaining bone levels, potentially due to the concentrated growth factors in PRF which might enhance tissue healing and stabilization around the implant.

The variability in these findings can be attributed to several factors, including differences in study design, measurement techniques, and follow-up periods. For instance, the two studies (11,12) that found no significant benefits had longer follow-up periods, potentially diluting the observable effects of PRF as other factors come into play over time. In contrast, studies (14,17) that reported positive outcomes focused on shorter follow-up periods where the immediate effects of PRF could be more distinctly observed.

Moreover, the PRF application method, the PRF type, and the implant procedure might also influence the outcomes. Studies demonstrating positive effects generally involved meticulous application techniques and optimized procedural protocols, which could enhance the efficacy of PRF.

While the results from these studies present a mixed view, they collectively suggest a potential role for PRF in enhancing peri-implant bone preservation, particularly in the early post-implantation phases.

Peri-Implant Bone Defects Treatment

Given the varying impacts of PRF on crestal bone stability, as observed in these studies, it is essential to consider how PRF could influence the treatment of peri-implant bone defects. In a study, Hamzacebi et al. (29) compared the clinical outcomes of PRF application versus conventional flap surgery in 19 patients experiencing peri-implant bone loss. The research aimed at evaluating the clinical effectiveness of PRF, specifically in its role in bone regeneration and implant stabilization. Results from the study indicated that the PRF group showed significantly better outcomes in terms of PPD reductions and clinical attachment level gains at both 3- and 6-months post-treatment. Notably, PRF treatment resulted in enhanced keratinized mucosa, suggesting improved soft tissue integration and stability around the implant sites. These findings underscore the potential of PRF to promote better bone healing and peri-implant stability.

5.4 Survival rate

Examining the literature on the effects of PRF on dental implant survival rates, it becomes apparent that none of the reviewed studies aimed to evaluate survival rates as their primary objective. Despite additional research, no studies were found that compare implant survival rates with and without the use of PRF.

Inconclusive data: trends and observations

Among the twelve studies considered, only six (10,11,14,17,20,21) provided explicit data on the survival rates for both the experimental (PRF) and control groups. This selective reporting underscores a significant gap in the literature, where survival rates, though crucial, are not always the central focus. More critically, none of these six studies presented statistical analysis regarding the significance of the differences in survival rates between groups treated with and without PRF. This absence of statistical scrutiny leaves a considerable void in our understanding, making it challenging to draw definitive conclusions about the efficacy of PRF in enhancing implant survival.

Two studies (10,14) suggest a trend towards higher survival rates in groups where PRF is utilized, reporting 100% and 94.4% survival rates, respectively, compared to 93.1% and

90% in their control groups. These results indicate a potentially favorable outcome from the use of PRF. However, the absence of statistical significance in these findings complicates the interpretation, as it remains unclear whether the differences are clinically meaningful or merely due to sample variability or study design.

Conversely, two studies (11,21) present a different perspective, reporting a lower survival rate in the PRF group than controls. This introduces a critical caution into the PRF narrative: PRF may not consistently enhance implant survival, and its efficacy may be contingent upon other surgical or patient-specific factors.

The study by Diana et al. (11) underscores the critical role of initial implant stability, highlighting that PRF cannot compensate for inadequate mechanical stability at implant placement. Their findings emphasize that the benefits of PRF are primarily supportive in enhancing biological healing rather than serving as a corrective measure for mechanical deficits.

Importantly, though the percentages indicate a notable difference, it is critical to recognize that the study (21) involved only 15 patients in each group, meaning that the actual difference involved only one additional implant failure in the PRF group compared to the control. Despite these differences in survival rates, both groups demonstrated similar timelines for the re-establishment of masticatory function, averaging between 71 and 73 days.

Comparative studies

In a retrospective study conducted by Raikar et al. (1) about the factors affecting the survival rate of dental implants, data from 5200 patients (2800 males and 2400 females) was examined to identify trends in implant failures related to various demographic and procedural variables. The study found that the highest number of implant failures (55) occurred in patients over 60. In contrast, younger groups—those under 40 and those between 41 and 60—experienced significantly fewer failures, with 20 and 45 failed implants, respectively. This research highlights that age, along with the length and diameter of the implant, the quality of the bone, and the region where the implant is placed, are critical factors determining the survival rate of dental implants.

The two remaining articles (17,20) report uniform success, each noting a 100% success rate without a comparative analysis, underscoring the need for well-structured comparative studies to truly ascertain the value of PRF in clinical practice.

To fully understand the results concerning survival rates with and without PRF, it is crucial to consider the findings from long-term studies such as the one conducted by Howe et al (30). In this systematic review, the 'absolute survival' rate over ten years has been assessed. The review found a summary estimate for 10-year implant survival at 96.4% with a prediction interval of 91.5%-99.4%, highlighting that older age (≥ 65 years) significantly predicts lower survival rates at 91.5%. These findings underscore the importance of considering age and other patient-specific factors as significant predictors of long-term dental implant survival, providing clinicians with a more nuanced understanding of potential risks in implant failure, particularly in older populations.

In contrast to the general gap in statistically significant data on PRF's influence on implant survival rates, a retrospective study by Marrelli and Tatullo (31) provides valuable insights into the long-term effects of PRF on dental implant stability. This study, conducted over 30 months, examined the outcomes of 127 tapered dental implants placed in immediate post-extraction sites. Remarkably, it reported a success rate of 99.8%, with only one implant failure attributed to peri-implantitis due to poor oral hygiene compliance. We couldn't include this study in our systematic review because it does not include a control group.

What sets this study apart is its comprehensive follow-up, assessing both the healing and the maintenance of peri-implant tissues. The use of PRF not only facilitated the rapid healing of soft tissues but also contributed to the long-term maintenance of crestal bone around the implants. This aligns with the observed trend towards higher survival rates in other studies utilizing PRF (10,14). The methodology of Marrelli and Tatullo (31) focuses on the direct application of PRF gel and membrane around the implant sites, offering a practical approach to enhance osseointegration and soft tissue integration, which are critical factors in implant success.

While some studies report mixed results, applying PRF under controlled and well-documented conditions, as demonstrated by Marrelli and Tatullo (31), could significantly enhance implant survival rates. This suggests that the benefits of PRF might be maximized in environments where surgical precision and patient compliance are rigorously managed. Hence, this study not only fills a critical gap by providing long-term data but also highlights the importance of surgical technique and patient management in achieving successful outcomes with PRF. It advocates for more rigorous, long-term studies to ascertain the consistent benefits of PRF, which could help mitigate the variability seen in smaller or less controlled studies.

5.5 Limitations

Sample Size and Generalizability

A recurring theme across numerous studies (10–12) is the limitation posed by small sample sizes. These sizes are insufficient to confidently extrapolate the results to the broader population, thereby compromising the statistical power and robustness of the conclusions drawn. For instance, studies with fewer than 40 participants (13,14) struggle to provide evidence regarding the effectiveness of PRF, highlighting the need for more extensive, multicentric trials that can offer more definitive evidence.

Study Design and Methodology

Several studies (19,20) exhibit critical limitations in their design and methodology, including non-randomized designs, lack of blinding, and the absence of control groups. Such deficiencies can introduce significant bias, affecting the reliability of the results. Moreover, the lack of diversity in study designs, with some employing split-mouth designs and others not, as well as variations in the surgical techniques and PRF application protocols, adds another layer of complexity to the comparative analysis across different studies.

Follow-up Duration and Outcome Measures

The short duration of follow-ups (15,17,18,20) limits the ability to assess the long-term effects of PRF on implant stability and bone integration. Dental implants are intended for long-term function; hence, understanding their performance over several years is crucial.

Additionally, reliance on specific, sometimes limited, measurement techniques like RFA or two-dimensional radiography restricts a comprehensive assessment of the outcomes. While useful, these methods fail to capture the full spectrum of biological and aesthetic impacts of PRF, suggesting a need for integrating more diverse and clinically relevant outcome measures in future research.

Demographic and Clinical Variability

The studies frequently focus on relatively homogeneous patient groups, often excluding potential complicating factors such as systemic diseases, smoking, or varying oral hygiene levels. This selective sampling, as noted in the research by Cheruvu et al. and Öncü et al. (14,15), limits the generalizability of the findings to a more typical clinical population, which is more diverse in terms of age, health status, and lifestyle factors.

Measurement and Analytical Techniques

The analytical techniques utilized to assess outcomes also present limitations. For example, the exclusive use of certain types of radiography or the absence of histological evaluations, as seen in the studies by Güvenç et al. and Fernandes et al. (20,21), may not adequately represent the three-dimensional changes in the bone or the detailed microstructural integration of implants with the surrounding tissue. Future studies could benefit from employing a broader array of diagnostic tools, including three-dimensional imaging and molecular analyses, to provide a more detailed and nuanced understanding of how PRF influences the implant healing process.

While the individual studies offer valuable insights into the potential benefits of PRF in enhancing dental implant outcomes, the collective limitations underscore the necessity for more rigorously designed, comprehensive, and long-term studies. Such research should aim to address these methodological shortcomings, incorporate broader and more diverse patient populations, and utilize a variety of outcome measures to more accurately determine the efficacy and applicability of PRF in dental implantology. These improvements could significantly enhance the reliability of research findings and better inform clinical practice.

6 Conclusion

The integration of PRF in dental implantology is a topic of significant interest, offering both promising potential and notable limitations. This systematic review has meticulously analyzed a range of studies to evaluate the efficacy of PRF in key areas such as enhancing implant stability, improving peri-implant tissue health, and preserving crestal bone levels.

The review suggests that PRF can significantly improve implant stability, particularly in the early stages of healing. Several studies have demonstrated substantial increases in ISQ with its application, indicating that PRF has the potential to expedite osseointegration by creating a favorable environment for bone regeneration. It is important to say that its benefits are most apparent in cases of moderate primary stability. However, the results across various studies are inconsistent, and the variability in results suggests that patient-specific factors and the precise application methods of PRF are crucial in determining its effectiveness.

While PRF appears to enhance soft tissue healing around implants by improving keratinized mucosa and reducing PPD in PRF-treated groups, its effect remains a puzzle. None of the studies have shown statistically significant improvements, leaving the impact of PRF unclear. The complexity of soft tissue healing, influenced by various biological and mechanical factors, necessitates further well-conducted studies to draw definitive conclusions.

Preserving crestal bone levels is crucial for the long-term success of dental implants. The review findings indicate mixed results regarding the impact of PRF on crestal bone preservation. Only some studies observed significant reductions in crestal bone loss with PRF use.

The review underscores a significant gap in the literature regarding the impact of PRF on dental implant survival rates. While a few studies have presented data on survival rates, they lack statistical analysis of the differences between PRF and control groups. Some studies have hinted at trends toward higher survival rates with PRF, but small sample sizes

and short follow-up periods limited these findings. Therefore, while PRF may show potential in improving survival rates, more robust and long-term studies are necessary to validate these findings and provide a solid foundation for future research.

Future studies should focus on larger, randomized controlled trials with standardized PRF preparation and application methods to conclusively determine the efficacy of PRF in dental implantology. Long-term follow-up is essential to assess the sustained benefits of PRF on implant stability, soft tissue health, and bone preservation.

In conclusion, while PRF holds promise as a beneficial adjunct to dental implant procedures, particularly for improving early implant stability and soft tissue healing, its use should be based on a careful evaluation of the available evidence and tailored to the specific needs of each patient. The proof of its long-term efficacy and impact on implant survival rates remains inconclusive. Further research with rigorous methodological standards is needed to fully understand and exploit the potential of PRF to improve dental implant outcomes.

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8 Annexes


EVENTOS CIENTÍFICOS IUCS
JORNADAS CIENTÍFICAS AEIUCS
XXXII JORNADAS CIENTÍFICAS DE CIÊNCIAS DENTÁRIAS
MENÇÃO HONROSA
PÓSTER
O Presidente das XXXII Jornadas Científicas de Ciências Dentárias certifica que:
Adida J, Coelho L
apresentaram um trabalho científico sob a forma de Póster intitulado, "Os beneficios do uso da fibrina rica em plaquetas na implantologia" no âmbito das XXXII Jornadas, subordinadas ao tema " Medicina Dentária Digital – Nova Era", que decorreram no dia 9 de abril de 2024, o qual foi distinguido com o prémio:
Menção Honrosa, pela Comissão Científica.
Presidente das XXXII Jornadas
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