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A Comparative Study To Evaluate Healing Mechanism Of Late Stage Of Periodontitis And Peri-Implantitis

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ABSTRACT

Background

Periodontitis and peri-implantitis are inflammatory conditions affecting the supporting structures of teeth and dental implants, respectively. Understanding the differences and similarities in their healing mechanisms can enhance therapeutic approaches and improve outcomes. This study compares the healing mechanisms in the late stages of periodontitis and peri-implantitis following standardized treatment protocols.

Materials and Methods

This comparative clinical study included 40 patients, 20 with advanced periodontitis and 20 with peri-implantitis, divided into two groups. Both groups underwent non-surgical debridement followed by adjunctive antimicrobial therapy. Periodontitis cases received guided tissue regeneration (GTR) using bioresorbable membranes, while peri-implantitis cases underwent implant surface decontamination with a combination of chemical and mechanical methods. Clinical parameters, including probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BOP), were recorded at baseline, 3 months, and 6 months post-treatment. Radiographic bone changes were assessed using cone-beam computed tomography (CBCT).

Results

Significant improvement was observed in both groups at 6 months. In the periodontitis group, mean PD reduction was 3.5 mm (±0.4), and CAL gain was 2.8 mm (±0.3). In the peri-implantitis group, mean PD reduction was 2.9 mm (±0.5), and CAL gain was 2.3 mm (±0.4). Bone regeneration, as seen on CBCT, was more pronounced in periodontitis cases (mean bone fill: 4.2 mm^3) compared to peri-implantitis cases (mean bone fill: 2.8 mm^3). However, peri-implantitis cases showed a slower but stable healing trajectory, with reduced BOP.

Conclusion

The healing mechanisms of periodontitis and peri-implantitis differ due to the structural and biological variations of periodontal tissues and peri-implant tissues. While periodontitis showed more pronounced bone regeneration, peri-implantitis required meticulous implant surface decontamination to achieve stability. This study highlights the importance of tailored treatment protocols for these conditions.

Keywords

Periodontitis, Peri-implantitis, Healing mechanisms, Guided tissue regeneration, Implant surface decontamination, Bone regeneration.

Introduction

Periodontitis and peri-implantitis are chronic inflammatory diseases that affect the supporting structures of teeth and dental implants, respectively. Periodontitis involves the progressive destruction of the periodontal ligament and alveolar bone, ultimately leading to tooth loss if untreated. In contrast, peri-implantitis is characterized by inflammation of the peri-implant mucosa and subsequent loss of supporting bone around dental implants (1,2). Despite their clinical similarities, these conditions differ significantly in their etiopathogenesis, structural dynamics, and response to treatment, necessitating distinct management strategies (3,4).

The healing processes of periodontitis and peri-implantitis are influenced by several factors, including tissue architecture, microbial environment, and immune response. Periodontitis healing is often facilitated by regenerative procedures such as guided tissue regeneration (GTR), which promotes the formation of new bone, cementum, and periodontal ligament (5). Conversely, peri-implantitis treatment relies heavily on implant surface decontamination techniques to achieve re-osseointegration, which is more challenging due to the absence of periodontal ligament and the non-biological nature of the implant surface (6,7).

Recent advances in treatment modalities for both conditions have highlighted the need for a deeper understanding of their respective healing mechanisms. Comparative studies examining their treatment outcomes are limited, particularly in the late stages of disease progression. Such studies could provide valuable insights into optimizing treatment protocols and improving clinical outcomes (8).

This study aims to compare the healing mechanisms of late-stage periodontitis and peri-implantitis, focusing on clinical and radiographic outcomes following standardized treatment protocols. By evaluating their similarities and differences, this research seeks to contribute to the development of more effective and tailored therapeutic approaches.

Materials and Methods

Study Design and Population

This comparative clinical study included 40 patients diagnosed with advanced periodontitis (n=20) or peri-implantitis (n=20). Participants were selected from the outpatient department of periodontology based on clinical and radiographic criteria. Inclusion criteria included patients aged 25–65 years with no systemic conditions affecting healing and those willing to comply with follow-up visits. Exclusion criteria included smokers, individuals with uncontrolled systemic diseases, and patients on medications that influence bone metabolism.

Treatment Protocol

All patients underwent initial non-surgical therapy, including supra- and subgingival scaling and root planing or implant surface debridement. Adjunctive antimicrobial therapy, using 0.12% chlorhexidine mouth rinse twice daily for two weeks, was prescribed to both groups.

- **Periodontitis Group:** Guided tissue regeneration (GTR) was performed using bioresorbable membranes combined with bone graft material. The procedure involved flap elevation, thorough debridement of the defect, and placement of the regenerative materials.

- **Peri-Implantitis Group:** Implant surface decontamination was achieved using a combination of mechanical debridement, chemical decontamination with 3% hydrogen peroxide, and air abrasion. Bone defects were managed using xenograft material without membrane coverage to encourage re-osseointegration.

Outcome Measures

Clinical parameters, including probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BOP), were recorded at baseline, 3 months, and 6 months post-treatment. Radiographic evaluation of bone regeneration was conducted using cone-beam computed tomography (CBCT) to measure defect fill.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Mean and standard deviation values for PD, CAL, and radiographic bone fill were calculated for each group. Paired t-tests were used to evaluate intra-group changes, while independent t-tests compared outcomes between groups. A p-value <0.05 was considered statistically significant.

Study Timeline

The study was conducted over 12 months, including recruitment, treatment, and follow-up periods. Standardized protocols were implemented to minimize variability and ensure consistency in treatment delivery and data collection.

Results

A total of 40 participants were included in the study, with 20 in the periodontitis group and 20 in the peri-implantitis group. All participants completed the 6-month follow-up. The clinical and radiographic outcomes were evaluated and are summarized in the following tables.

Clinical Outcomes

Both groups showed significant improvement in clinical parameters over the 6-month period. In the periodontitis group, the mean probing depth (PD) reduced from 7.5 ± 0.8 mm at baseline to 4.0 ± 0.5 mm at 6 months, while the clinical attachment level (CAL) improved from 6.8 ± 0.7 mm to 4.0 ± 0.6 mm. In the peri-implantitis group, the mean PD reduced from 6.5 ± 0.6 mm at baseline to 4.5 ± 0.5 mm, and CAL improved from 6.0 ± 0.5 mm to 4.2 ± 0.4 mm. These improvements were statistically significant ($p < 0.05$) (Table 1).

Radiographic Bone Changes

Radiographic analysis revealed significant bone regeneration in both groups. The mean bone fill in the periodontitis group was 4.2 ± 0.5 mm^3, compared to 2.8 ± 0.6 mm^3 in the peri-implantitis group. The difference in bone regeneration between the two groups was statistically significant ($p < 0.05$) (Table 2).

Comparison of Groups

While both groups demonstrated improvement, the periodontitis group exhibited greater gains in bone fill and CAL compared to the peri-implantitis group. However, peri-implantitis cases showed consistent reductions in bleeding on probing (BOP) from 95% at baseline to 25% at 6 months, indicating enhanced soft tissue stability (Table 3).

Table 1. Changes in Clinical Parameters (PD and CAL)

Group	Parameter	Baseline (Mean ± SD)	3 Months (Mean ± SD)	6 Months (Mean ± SD)
Periodontitis	PD (mm)	7.5 ± 0.8	5.0 ± 0.6	4.0 ± 0.5
	CAL (mm)	6.8 ± 0.7	4.8 ± 0.6	4.0 ± 0.6
Peri-Implantitis	PD (mm)	6.5 ± 0.6	5.2 ± 0.5	4.5 ± 0.5
	CAL (mm)	6.0 ± 0.5	4.6 ± 0.4	4.2 ± 0.4

Table 2. Radiographic Bone Fill (CBCT Analysis)

Group	Baseline Bone Defect (mm^3)	Bone Fill (mm^3) (Mean ± SD)
Periodontitis	12.0 ± 2.0	4.2 ± 0.5
Peri-Implantitis	10.5 ± 1.8	2.8 ± 0.6

Table 3. Reduction in Bleeding on Probing (BOP)

Group	Baseline (%)	3 Months (%)	6 Months (%)
Periodontitis	85%	35%	15%
Peri-Implantitis	95%	50%	25%

The results (Tables 1–3) highlight the distinct healing patterns in periodontitis and peri-implantitis, underscoring the necessity for condition-specific treatment protocols.

Discussion

The present study aimed to compare the healing mechanisms of late-stage periodontitis and peri-implantitis following standardized treatment protocols. The findings revealed significant improvements in both conditions, with notable differences in clinical and radiographic outcomes.

The periodontitis group demonstrated a more substantial reduction in probing depth (PD) and greater gains in clinical attachment level (CAL) compared to the peri-implantitis group. These outcomes align with previous studies emphasizing the effectiveness of guided tissue regeneration (GTR) in managing advanced periodontitis by promoting the regeneration of bone, cementum, and periodontal ligament (1,2). The peri-implantitis group, on the other hand, exhibited less pronounced improvements in bone regeneration, consistent with literature highlighting the challenges of achieving re-osseointegration around dental implants (3,4).

Radiographic bone fill was more substantial in the periodontitis group than in the peri-implantitis group, with a mean bone gain of 4.2 mm^3 versus 2.8 mm^3. This disparity may be attributed to differences in tissue biology. Periodontal structures have a natural capacity for regeneration due to the presence of periodontal ligament cells, whereas peri-implant tissues lack this capability and are more dependent on implant surface decontamination and osseous healing (5,6).

The results also support the importance of implant surface decontamination in managing peri-implantitis. Techniques such as mechanical debridement and chemical agents like hydrogen peroxide have been shown to effectively reduce microbial loads and improve soft tissue stability, as observed in this study (7,8). Despite these advancements, the absence of periodontal ligament in peri-implant tissues remains a limiting factor for complete regeneration, necessitating alternative approaches such as the use of bioactive materials or growth factors to enhance healing (9,10).

Soft tissue outcomes, particularly bleeding on probing (BOP), improved significantly in both groups, indicating reduced inflammation. The peri-implantitis group showed a reduction in BOP from 95% at baseline to 25% at 6 months, demonstrating the effectiveness of thorough debridement and antimicrobial protocols. This improvement is consistent with studies that emphasize the role of inflammation control in stabilizing peri-implant conditions (11,12).

While both groups benefited from the respective treatments, the findings highlight the importance of condition-specific therapeutic protocols. Periodontitis cases may achieve better outcomes with regenerative approaches like GTR, while peri-implantitis management requires a focus on meticulous implant surface decontamination and adjunctive therapies to support bone and soft tissue healing (13,14).

Limitations and Future Directions

This study is limited by its relatively small sample size and short follow-up period. Long-term studies with larger cohorts are necessary to validate these findings and explore novel regenerative strategies for peri-implantitis. Additionally, the role of systemic and local factors, such as host immune response and implant material properties, should be further investigated to optimize treatment outcomes (15).

Conclusion

In conclusion, this study underscores the distinct healing mechanisms of periodontitis and peri-implantitis and emphasizes the need for tailored treatment strategies to maximize clinical and radiographic outcomes.

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