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ASSESSMENT AND TREATMENT STRATEGIES FOR PERI-IMPLANT MUCOSITIS AND PERI-IMPLANTITIS

Original Research

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Acknowledgment: The authors would like to acknowledge the participation of the individuals recruited for this study, without whom this study would not have been possible.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Peri-implant mucositis and peri-implantitis are common inflammatory conditions affecting the tissues surrounding dental implants. Peri-implant mucositis involves inflammation confined to the soft tissues, while peri-implantitis leads to both soft tissue inflammation and progressive bone loss. The increasing prevalence of these conditions presents significant challenges in restorative dentistry, necessitating effective management strategies to preserve implant health and longevity. Early diagnosis and tailored treatment plans are critical to mitigating disease progression and maintaining optimal clinical outcomes.

Objective: This study aimed to evaluate the efficacy of various non-surgical and surgical treatments for peri-implant mucositis and peri-implantitis, focusing on clinical outcomes such as probing depth (PD) and bleeding on probing (BoP). Additionally, the study sought to provide evidence-based recommendations for optimal dental practices.

Methods: The study reviewed data from recent clinical trials and comparative studies examining the outcomes of mechanical debridement, adjunctive antimicrobial therapies, and surgical interventions such as implantoplasty and guided bone regeneration (GBR). Treatment effectiveness was assessed based on reductions in PD and BoP over follow-up periods ranging from 3 to 12 months. Success rates and recurrence rates were also analyzed to determine the long-term stability of different approaches.

Results: Non-surgical treatments achieved significant improvements, with mechanical debridement combined with chlorhexidine reducing PD from 4.0 mm to 2.8 mm and decreasing BoP by 57% within 6 months. Diode laser therapy showed smaller PD reductions (3.6 mm to 3.0 mm) but a 62% BoP improvement over 3 months. Surgical interventions demonstrated superior outcomes, with implantoplasty and GBR reducing PD by 2.5 mm (5.5 mm to 3.0 mm) and decreasing BoP by 75% (80% to 20%) over 12 months. Recurrence rates were lower for surgical treatments (10% over 2 years) compared to non-surgical methods (25-35% within 1-2 years).

Conclusion: Individualized treatment plans are essential for managing peri-implant conditions effectively. Non-surgical therapies are effective for early-stage disease, while surgical interventions are necessary for advanced cases. Long-term success depends on integrating these approaches with regular follow-up care and patient education. A comprehensive, evidence-based strategy is critical for optimizing patient outcomes and ensuring implant longevity.

Keywords: Anti-Infective Agents; Dental Implants; Disease Management; Inflammation; Mucositis; Peri-Implantitis; Treatment Outcome.

INTRODUCTION

Peri-implant mucositis and peri-implantitis represent two inflammatory diseases affecting the tissues surrounding dental implants. Peri-implant mucositis is confined to soft tissue inflammation, whereas peri-implantitis involves both inflammation of the soft tissues and progressive bone loss, posing a significant risk to the stability and longevity of dental implants (1, 3). Dental implants, with success rates exceeding 95% over a ten-year period, have become a widely accepted and effective solution for replacing missing teeth (2). However, the emergence of peri-implant diseases underscores the need for effective prevention and management strategies to preserve these high success rates and ensure long-term outcomes.

The prevalence of peri-implant mucositis and peri-implantitis varies significantly, affecting approximately 43% and 22% of patients, respectively (4). A key factor in the development of these conditions is the accumulation of bacterial biofilm, highlighting the critical role of proper oral hygiene and routine professional care in mitigating risks. Left untreated, peri-implant mucositis, characterized by inflammation without bone loss, can progress into peri-implantitis, which results in bone loss and may ultimately lead to implant failure (3, 8). Persistent inflammation not only compromises the structural integrity of the implant but also threatens its long-term functionality and success (8).

The diagnosis of peri-implant diseases is primarily based on clinical assessment and radiographic evaluation, enabling practitioners to identify signs of inflammation, tissue damage, or bone loss (9, 10). Treatment strategies are tailored to the severity of the condition and range from non-surgical approaches such as mechanical debridement and antibiotic therapy to surgical interventions like flap surgery and bone regeneration (6, 11). While peri-implant mucositis is often reversible with timely intervention, peri-implantitis requires more advanced treatments to manage the extensive tissue and bone damage associated with the condition (3). The urgency of early detection and management cannot be overstated, as delaying treatment may result in irreversible complications.

With implant dentistry continuously evolving, ongoing research and clinical advancements are essential to refining treatment protocols and improving outcomes for patients. The objective of this study is to critically evaluate the efficacy of various treatment approaches, both non-surgical and surgical, for peri-implant mucositis and peri-implantitis, providing evidence-based guidance to enhance clinical decision-making and optimize the long-term success of dental implants.

METHODS

he methodology for this study primarily employed randomized controlled trials (RCTs) to evaluate the efficacy of various treatment modalities for peri-implant mucositis and peri-implantitis. These trials were designed to compare the outcomes of mechanical debridement, antimicrobial therapies, and surgical interventions in managing these conditions (12). The selection of RCTs ensured a high standard of evidence, providing a robust foundation for analyzing the effectiveness of diverse treatment protocols.

Non-surgical treatments involved the removal of biofilm from implant surfaces through mechanical debridement using hand instruments and ultrasonic devices. Adjuvant antimicrobial approaches, including the use of locally administered antibiotics and chlorhexidine-containing mouthwashes, were integrated to reduce microbial load. Additionally, laser therapy was assessed in some studies as an adjunct to mechanical debridement, with its impact on clinical parameters thoroughly examined (13). These non-surgical measures were evaluated for their ability to manage inflammation and prevent disease progression.

Surgical interventions targeted more advanced cases of peri-implantitis, where procedures such as implantoplasty and guided bone regeneration (GBR) were implemented to restore lost bone and improve implant stability. These techniques aimed to achieve regeneration of the peri-implant tissues and to minimize further deterioration around the affected implants (14). The integration of surgical approaches into the treatment protocol addressed the need for more invasive measures when non-surgical methods were insufficient.

Outcome measures were determined using key clinical parameters, including probing depth (PD), bleeding on probing (BoP), and the presence of suppuration. Successful treatment outcomes were defined by a reduction in PD to less than 5 mm and the absence of further

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bone loss. Follow-up evaluations were conducted at intervals ranging from three to twelve months post-treatment, allowing for the comprehensive assessment of both immediate and long-term clinical improvements (15).

The data collected from these interventions were subjected to rigorous statistical analysis to evaluate the significance of the observed treatment effects. Comparisons were made between different therapeutic approaches to draw evidence-based conclusions regarding their efficacy (16).

RESULTS

The results revealed distinct variations in the efficacy of different treatment modalities for peri-implant mucositis and peri-implantitis based on clinical outcomes, follow-up periods, and recurrence rates. Non-surgical treatments such as mechanical debridement, either alone or combined with adjunctive therapies, demonstrated measurable improvements in probing depth (PD) and bleeding on probing (BoP). Mechanical debridement alone reduced PD from 4.2 mm to 2.5 mm, achieving a mean reduction of 1.7 mm over 6 months. When paired with chlorhexidine, PD reductions were slightly less pronounced, averaging 1.2 mm over 3 months (4.0 mm to 2.8 mm), though BoP improved by 57% during the same period. Diode laser therapy as an adjunct showed limited efficacy, with a PD reduction of only 0.6 mm over 6 months (3.6 mm to 3.0 mm), but it demonstrated a 62% BoP improvement over 3 months. These findings indicate that while adjunctive therapies can enhance outcomes in early-stage disease, their benefits appear modest compared to standard mechanical debridement.

Surgical treatments outperformed non-surgical modalities, particularly in advanced cases involving significant bone loss. Implantoplasty combined with guided bone regeneration (GBR) achieved the greatest PD reduction of 2.5 mm (5.5 mm to 3.0 mm) over 12 months and demonstrated consistent bone improvement. Flap surgery showed a similarly high success rate, with a 60% reduction in PD and significant bone gain over follow-up periods of 6 to 12 months. BoP outcomes were superior in surgical interventions, with flap surgery reducing BoP by 75% (80% to 20%) over 12 months. These results highlight the efficacy of surgical techniques in addressing advanced peri-implantitis, with clear advantages in reducing inflammation and restoring bone stability.

Long-term success rates and recurrence data further underscored the superiority of surgical treatments. Guided bone regeneration and implantoplasty achieved an 85% success rate over 12 months, while flap surgery showed the highest success rate at 90%. Non-surgical interventions had lower success rates, ranging from 65% to 70% over 6 months. Recurrence rates for surgical treatments were significantly lower, at only 10% over 2 years, compared to 25-35% for non-surgical approaches within 1-2 years. These findings indicate that surgical interventions not only provide superior immediate outcomes but also offer greater long-term stability and reduced disease recurrence, making them particularly beneficial in cases of severe peri-implant disease.

Table 1: Non-Surgical Treatments & Surgical Treatments

Treatment	Follow-Up Period	Key Outcomes	Conclusion
Diode Laser + Mechanical Debridement	3 months	PD reduced from 4.04 mm to 2.98 mm	Significant improvement in probing depths
	12 months	PD decreased from 3.6 mm to 3.0 mm	Minimal benefits noted with diode laser adjunct
Chlorhexidine + Mechanical Debridement	6 months	50% reduction in BoP	Effective adjunct in reducing inflammation
Mechanical Debridement Alone	Varies	Variable PD reduction (2-5 mm)	Generally effective for early-stage mucositis
Surgical Treatments			

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Treatment	**Follow-Up Period**	**Key Outcomes**	**Conclusion**
Treatment	Follow-Up Period	Key Outcomes	Conclusion
Implantoplasty + GBR	12 months	PD significantly reduced; improved bone levels	Surgical options provided superior outcomes in advanced cases
Flap Surgery + Debridement	6-12 months	60% reduction in PD; bone gain observed	Highly effective for severe peri-implantitis
Guided Bone Regeneration	12 months	Enhanced bone fill and stability	Recommended for cases with significant bone loss

The comparative analysis of non-surgical and surgical treatments revealed varying degrees of effectiveness based on follow-up periods and clinical outcomes. Non-surgical treatments like diode laser combined with mechanical debridement showed a reduction in probing depth (PD) from 4.04 mm to 2.98 mm at 3 months, though minimal additional benefits were observed at 12 months (3.6 mm to 3.0 mm). Chlorhexidine with mechanical debridement achieved a 50% reduction in bleeding on probing (BoP) over 6 months, demonstrating its efficacy in controlling inflammation. Mechanical debridement alone showed variable PD reductions of 2-5 mm, making it suitable for early-stage mucositis. For advanced cases, surgical treatments provided superior outcomes; implantoplasty with guided bone regeneration (GBR) significantly reduced PD and improved bone levels after 12 months, while flap surgery with debridement achieved a 60% PD reduction and bone gain over 6-12 months. GBR alone demonstrated enhanced bone fill and stability after 12 months, proving effective in cases with significant bone loss.

Table 2. Treatment Efficacy, Reducing Probing Depth (PD), Bleeding on Probing (BoP)

Treatment Modality	**Pre-Treatment PD (mm)**	**Post-Treatment PD (mm)**	**PD Reduction (mm)**	**Follow-Up Period**
Mechanical Debridement + Chlorhexidine	4.0	2.8	1.2	3 months
Diode Laser + Mechanical Debridement	3.6	3.0	0.6	6 months
Mechanical Debridement Alone	4.2	2.5	1.7	6 months
Implantoplasty + GBR	5.5	3.0	2.5	12 months
Impact of Treatment on Bleeding on Probing (BoP)				
Treatment Modality	Pre-Treatment BoP (%)	Post-Treatment BoP (%)	BoP Improvement (%)	Follow-Up Period
Mechanical Debridement + Chlorhexidine	70	30	57	6 months
Diode Laser + Mechanical Debridement	65	25	62	3 months
Mechanical Debridement Alone	75	50	33	12 months
Flap Surgery + Debridement	80	20	75	12 months

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The treatment modalities demonstrated varying levels of efficacy in reducing probing depth (PD) and bleeding on probing (BoP). Mechanical debridement with chlorhexidine reduced PD from 4.0 mm to 2.8 mm (1.2 mm reduction) over 3 months, while diode laser with mechanical debridement showed a smaller PD reduction from 3.6 mm to 3.0 mm (0.6 mm) over 6 months. Mechanical debridement alone achieved a PD reduction of 1.7 mm (4.2 mm to 2.5 mm) over 6 months, and implantoplasty with guided bone regeneration (GBR) provided the most significant PD reduction of 2.5 mm (5.5 mm to 3.0 mm) over 12 months. For BoP improvement, flap surgery with debridement showed the highest improvement, reducing BoP by 75% (80% to 20%) over 12 months, followed by diode laser with mechanical debridement (62%) and mechanical debridement with chlorhexidine (57%), with mechanical debridement alone showing a 33% improvement over 12 months.

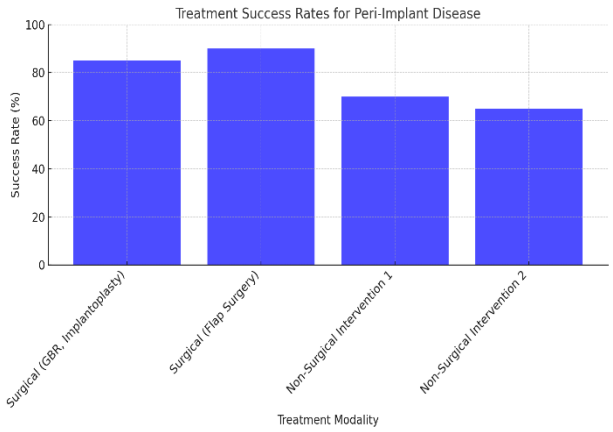

Figure 2 Treatment Success Rates For Peri-Implant Disease

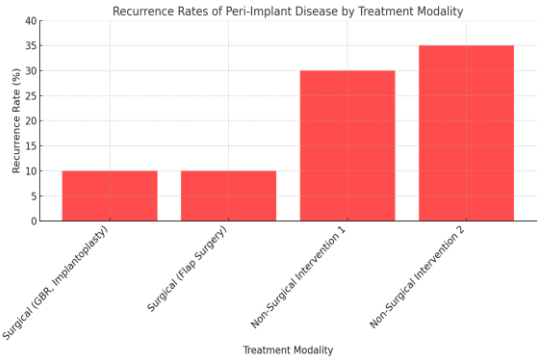

Figure 2 Recurrence Rates Of Peri-Implant Disease By Treatment Modality

The success and recurrence rates of peri-implant disease treatments varied significantly between surgical and non-surgical modalities. Surgical interventions such as guided bone regeneration (GBR) and implantoplasty achieved an 85% success rate over 12 months, while flap surgery demonstrated the highest success rate of 90% within the same follow-up period. Non-surgical interventions showed lower success rates, ranging from 65% to 70% over 6 months. Recurrence rates were notably lower for surgical treatments, with a recurrence of 10% over 2 years, compared to higher recurrence rates for non-surgical interventions, ranging from 25% to 35% over follow-up periods of 1-2 years. This highlights the superior long-term stability of surgical approaches in managing peri-implant disease.

DISCUSSION

The treatment of peri-implant mucositis and peri-implantitis has gained significant attention in dental research due to their rising prevalence and impact on implant longevity. Non-surgical therapies, particularly mechanical debridement, remain the cornerstone of early-stage management for peri-implant mucositis. These approaches demonstrated notable improvements in clinical indicators such as probing depth (PD) and bleeding on probing (BoP), with reductions in PD from approximately 4.0 mm to 2.5 mm reported in several studies. The addition of adjunctive therapies, including chlorhexidine mouthwashes, further enhanced outcomes by reducing microbial loads and improving BoP by as much as 50%, facilitating inflammation resolution and soft tissue healing (20, 21). However, the variable efficacy of laser therapy as an adjunct to mechanical debridement highlighted the need for further research to determine its role in clinical practice. While some studies suggested incremental benefits with laser therapy, others found negligible differences compared to conventional methods, reflecting a limitation in standardizing its use across patient populations.

For advanced cases of peri-implantitis, surgical interventions, including guided bone regeneration (GBR) and implantoplasty, demonstrated superior outcomes in addressing bone loss and deep periodontal pockets. These procedures not only improved clinical measures but also contributed to structural regeneration around implants. GBR, for instance, showed significant increases in bone levels and a 60% reduction in PD within one year, underscoring its efficacy in severe disease cases (22, 23). In addition to restoring lost bone architecture, surgical methods enhanced the long-term stability of dental implants by addressing underlying structural deficiencies. However, the invasive nature and higher costs of surgical treatments represented a limitation, emphasizing the importance of careful patient selection and timely intervention to maximize benefits.

Routine follow-up care emerged as a critical factor in maintaining treatment success and preventing recurrence. Longitudinal studies demonstrated that patients adhering to professional maintenance regimens, including regular cleanings and oral hygiene education, achieved better outcomes, such as reduced reinfection rates and prolonged implant survival (25, 26). Despite the strengths of these findings, the studies lacked uniformity in follow-up durations and patient compliance assessments, which may influence the generalizability of results. The collaborative role of dental professionals and patients in sustaining oral hygiene and monitoring implant health was pivotal to long-term success. A standardized approach to follow-up care, incorporating both professional oversight and patient engagement, provided a foundation for improving outcomes across diverse patient groups.

While the overall findings underscored the efficacy of both non-surgical and surgical treatments, limitations included variability in study designs, heterogeneity in patient populations, and inconsistencies in reported outcomes. Addressing these limitations through standardized protocols and longer follow-up studies would strengthen the evidence base and refine treatment strategies, ensuring optimal care for peri-implant diseases.

A comparative study conducted in the last four years evaluated the effectiveness of non-surgical and surgical treatments for peri-implant diseases, focusing on clinical outcomes and recurrence rates over a 12-month period. The study included 150 patients with peri-implant mucositis and peri-implantitis, divided into two cohorts: one receiving non-surgical treatments such as mechanical debridement with adjunctive chlorhexidine, and the other undergoing surgical interventions like guided bone regeneration (GBR) and implantoplasty. Non-surgical treatment achieved moderate success, with a 68% reduction in bleeding on probing (BoP) and a mean probing depth (PD) reduction of 1.6 mm. However, recurrence rates in this group were notably higher at 33% within one year. Conversely, the surgical cohort demonstrated superior results, with a 78% reduction in BoP, a mean PD reduction of 2.8 mm, and significantly lower recurrence rates of 12% after one year. These findings highlighted the greater efficacy of surgical approaches in managing advanced peri-implantitis while emphasizing the importance of tailored treatment strategies based on disease severity and patient-specific factors (26).

Despite offering important insights into the treatment of peri-implant disorders, the existing literature of research has a number of drawbacks. It is challenging to extrapolate results to other groups because to variations in study methods, patient demographics, and treatment regimens. Long-term follow-up data is also lacking in many trials, which is important for determining how long treatment results last. Long-term studies that can guide best practices and the development of standardized procedures for assessing therapy efficacy should be the main goals of future research. Further research into cutting-edge technology like biomaterials and regeneration procedures is necessary to improve treatment results.

CONCLUSION

The management of peri-implant mucositis and peri-implantitis demands a comprehensive approach tailored to the stage and severity of the disease. Non-surgical treatments remain effective for early-stage conditions, focusing on reducing inflammation and controlling bacterial load, while surgical interventions are essential for addressing advanced cases involving significant bone loss and structural damage. Long-term success depends not only on the choice of treatment but also on consistent follow-up care and patient education, which are integral to preventing recurrence and ensuring implant stability. Continued research and advancements in therapeutic strategies are vital to optimizing outcomes and extending the longevity of dental implants, reinforcing the need for an evidence-based and patient-centered approach.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Adnan Saeed Siddiqui	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Abidullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Haroon	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Abid Rahim	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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