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REVIEW

Regenerative and adjunctive surgical strategies in peri-implantitis: A mini-review

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ABSTRACT

Peri-implantitis is a major biological complication that threatens the long-term success of dental implants. The progression from peri-implant mucositis to advanced bone loss often necessitates a shift from non-surgical to surgical treatment, although the most effective management protocols remain under debate. This mini-review aims to evaluate and compare clinical outcomes of three distinct approaches to peri-implantitis management: the diagnostic necessity of surgical access, conventional guided bone regeneration (GBR) combined with antibiotics, and adjunctive topical oxygen therapy. A narrative review was conducted, and three representative clinical case reports were purposively selected for detailed analysis. These cases illustrate different therapeutic strategies currently applied in clinical practice. The findings emphasize that surgical intervention is crucial for halting disease progression when non-surgical access proves inadequate. Conventional GBR supplemented with local antibiotics provided exceptional stability during a 17-year follow-up period. In contrast, the application of a topical oxygen gel (BlueM) yielded encouraging 5-year outcomes, demonstrating reduced inflammation and enhanced bone regeneration without the use of antibiotics. The success of all treatment modalities depended heavily on meticulous surface decontamination and thorough defect debridement. Surgical management of peri-implantitis should be tailored to the specific defect morphology. While GBR with antibiotics remains a well-established long-term reference, adjunctive oxygen therapy offers a promising non-antibiotic alternative for infection control. Further randomized controlled trials are warranted to establish standardized clinical protocols.

Keywords: dental implant, peri-implantitis, surgical treatment, bone regeneration, oxygen therapy

INTRODUCTION

Dental implants have replaced conventional dentures as the standard of care for tooth replacement, offering high predictability and patient satisfaction.[1] However, the rising prevalence of implant therapy has been accompanied by an increase in biological complications, particularly peri-implantitis.[2] Peri-implantitis is an inflammatory disease involving the soft and hard tissues surrounding an osseointegrated implant, resulting in progressive alveolar bone loss.[3–5] It is primarily caused by the accumulation of pathogenic biofilm and is characterized clinically by bleeding on probing (BOP), suppuration, increased probing pocket depths (PPD > 4–5 mm), and radiographic evidence of bone loss.[4,6–8] Reported risk factors include a history of periodontitis, poor oral hygiene, residual subgingival cement, and excessive occlusal loading.[3,9–12]

The management of peri-implantitis is complex and depends on disease severity. Non-surgical therapy, including mechanical debridement and the use of antimicrobial agents, may be effective for peri-implant mucositis (inflammation without bone loss) but has shown limited success in stopping the progression of peri-implantitis.[7,13] Therefore, surgical intervention is often required in moderate to severe cases to access and decontaminate the implant surface and regenerate lost bone using various grafting materials and techniques.[3,14–17]

Although dental implants have become the preferred treatment option for tooth replacement, the increasing incidence of peri-implantitis threatens their long-term success. This condition is distinguished from peri-implant mucositis by the presence of progressive bone loss in addition to soft tissue inflammation.

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While non-surgical mechanical debridement can effectively manage early mucositis, it has limited predictability in controlling peri-implantitis because complete decontamination of the rough implant surface is difficult without surgical access. Consequently, surgical procedures are often necessary to achieve thorough debridement and enable regenerative therapy. Current surgical protocols vary widely, incorporating systemic antibiotics, bone grafts, and newer adjunctive treatments such as topical oxygen agents.

This mini-review aims to analyze clinical evidence from representative case reports to compare the outcomes of conventional regenerative surgery and emerging adjunctive therapies in peri-implantitis management. The objective is to provide clinicians with an evidence-based perspective on contemporary surgical strategies for improving peri-implantitis treatment outcomes.

METHOD

This study uses a narrative review approach to synthesize real-world evidence on the surgical management of peri-implantitis. A targeted literature search was conducted through PubMed and Google Scholar using keywords such as "peri-implantitis surgical treatment," "bone regeneration," and "adjunctive implant therapy" to identify relevant clinical scenarios. From the search results, three clinical cases[2,3,13] were purposefully selected for their illustrative value. The selection was not intended as an exhaustive systematic review but rather as a representation of three distinct paradigms within current clinical practice: (1) establishing a diagnostic baseline to differentiate mucositis from peri-implantitis in determining surgical necessity, (2) the use of topical oxygen therapy as a modern non-antibiotic adjunct, and (3) the long-term benchmark of conventional guided bone regeneration with follow-up exceeding 15 years.

For each selected case, detailed information was extracted using a standardized template. The extracted data included patient demographics, relevant medical history, and implant characteristics such as location and duration in function prior to complication. Clinical presentation was documented by recording the chief complaint, probing pocket depths (PPD), bleeding on probing (BOP), suppuration, and implant mobility, together with radiographic findings describing the extent of bone loss and defect morphology. A comprehensive account of the treatment protocol was compiled, detailing the surgical technique, surface decontamination method, and specific regenerative materials used. Finally, a qualitative comparison of therapeutic outcomes was conducted, emphasizing long-term stability to elucidate the rationale, benefits, and limitations of each surgical strategy based on the documented clinical and radiographic results.

RESULTS

A review of selected clinical cases demonstrated that therapeutic outcomes varied considerably according to disease severity and the surgical protocol implemented. Based on the diagnostic analysis by Thakkar et al., significant clinical distinctions were observed between peri-implant mucositis and peri-implantitis. Their findings indicated that while mucositis can be effectively managed with nonsurgical therapy, established peri-implantitis, characterized by pronounced pocket depth and advanced bone loss, does not respond predictably to mechanical debridement alone. The authors concluded that surgical access remains an essential prerequisite for effective decontamination of implant surfaces in cases involving advanced osseous destruction.

Table 1. Summary of clinical cases and surgical outcomes

Study	Defect Type	Surgical Protocol	Follow-up Period	Key Findings
Thakkar et al. (2017)	Peri-implantitis	Surgical access required (compared with non-surgical approach)	N/A	Demonstrated that surgical intervention is essential for managing deep peri-implant defects.
Bassi et al. (2015)	Severe bone loss	Debridement with tetracycline application followed by guided bone regeneration (GBR)	17 years	Achieved long-term stability and successful bone preservation.
Tanka & Alshehri (2023)	Peri-implantitis	Debridement with BlueM oxygen gel followed by guided bone regeneration (GBR)	5 years	Produced significant bone fill and proved effective without antibiotic use.

Regarding long-term outcomes associated with conventional regenerative procedures, the case reported by Bassi et al. demonstrated favorable results for a surgical approach applied to severe peri-implantitis defects. The treatment protocol included open-flap debridement, chemical decontamination with tetracycline, and guided bone regeneration (GBR) using bovine-derived bone and a collagen membrane. This combination exhibited long-term clinical stability. Seventeen-year follow-up data revealed restoration of probing depth to physiologic limits without bleeding on probing (BOP). Radiographic evaluation confirmed

that bone height remained stable, with no evidence of progressive resorption throughout nearly two decades of postoperative observation.

In contrast, Tanka & Alshehri[2] proposed a more recent protocol incorporating topical oxygen therapy (BlueM gel) as a surgical adjunct without the use of local or systemic antibiotics. The 5-year follow-up demonstrated complete resolution of peri-implant inflammation and a substantial reduction in pocket depth. Radiographic assessment confirmed significant bone fill within the treated defects. Moreover, no adverse reactions were reported, supporting the high biocompatibility and favorable safety profile of the oxygen-releasing agent.

DISCUSSION

The findings of this review emphasize a critical consensus in implant dentistry: mechanical debridement alone is often insufficient for the management of advanced peri-implantitis. As reported by Thakkar et al.[13], the complex geometries of implant surfaces often provide bacterial refuges that are inaccessible to non-surgical instrumentation, making flap reflection an essential step for direct visualization and mechanical debridement of the defect. This reinforces the distinction between peri-implant mucositis and peri-implantitis; while peri-implant mucositis generally responds to conservative therapy, peri-implantitis typically requires surgical intervention to effectively arrest disease progression.

A comparative analysis of therapeutic protocols reveals a notable shift in treatment philosophy from antibiotic-dependent regimens to biomimetic approaches. The 17-year clinical stability reported by Bassi et al.[3] presents strong evidence that Guided Bone Regeneration (GBR) combined with tetracycline remains a benchmark for long-term success. However, despite its documented efficacy in individual cases, the routine use of local antibiotics warrants caution due to legitimate concerns about the growing global issue of antimicrobial resistance. In contrast, the protocol proposed by Tanka & Alshehri[2] introduces a contemporary approach employing topical oxygen therapy. This method aligns with current principles that favor minimizing pharmaceutical overuse by establishing an oxygen-rich environment unfavorable to anaerobic pathogens while promoting angiogenesis and accelerating tissue repair. Although its five-year follow-up period is shorter than that of Bassi et al.[3], the clinical outcomes suggest that oxygen therapy represents a viable non-antibiotic alternative for surface decontamination.

It should be noted, however, that this review is limited to isolated case reports, which inherently restricts generalizability. The lack of control groups in these studies makes it difficult to distinguish the independent effects of adjunctive agents, such as BlueM gel or tetracycline, from those of surgical debridement alone. Therefore, while the reported results are encouraging, they must be interpreted with caution. Future investigations should prioritize randomized controlled trials (RCTs) with larger sample sizes to directly compare the efficacy of different decontamination modalities and to develop more standardized clinical guidelines.

CONCLUSION

Peri-implantitis management generally requires progression from non-surgical to surgical treatment as the disease advances. Evidence from the reviewed cases demonstrates that surgical intervention is essential to adequately access and decontaminate the implant surface. A combined technique involving bone grafts and barrier membranes has shown stable long-term results, supported by 17 years of follow-up data. Adjunctive oxygen therapy (BlueM) appears to be a promising innovation, effectively reducing inflammation and enhancing bone regeneration without relying on antibiotics. Future research should emphasize randomized controlled trials comparing the efficacy of oxygen-releasing agents with conventional antibiotic protocols to optimize clinical treatment guidelines.

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