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RESEARCH ARTICLE

SIMULTANEOUS GUIDED BONE AND SOFT TISSUE REGENERATION WITH DENTAL IMPLANTS IN THE MAXILLARY PREMOLAR REGION: CLINICAL APPLICATION OF ACELLULAR DERMAL MATRIX FOR FUNCTIONAL AND AESTHETIC REHABILITATION

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ABSTRACT

Background: Dental implants are widely used for the replacement of missing teeth and have shown predictable long-term outcomes when appropriate surgical and prosthetic protocols are followed. However, successful implant therapy requires sufficient alveolar bone volume and stable peri-implant soft tissues. In situations where ridge resorption and thin mucosal phenotypes are present, regenerative procedures may be required to establish a favourable biological environment for implant placement. Guided bone regeneration (GBR) and acellular dermal matrix (ADM) grafting are commonly used techniques to improve both hard and soft tissue conditions around implants (1–3). **Case Presentation:** A 42-year-old male patient presented with missing maxillary premolars and complained of difficulty during mastication. Clinical and radiographic examination revealed horizontal ridge deficiency and a thin peri-implant mucosal phenotype. Implant rehabilitation was planned with simultaneous hard- and soft-tissue augmentation. **Management and Outcome:** Two dental implants were placed in the maxillary premolar region. Guided bone regeneration was performed using particulate bone graft material and a resorbable collagen membrane to address the buccal bone deficiency. An acellular dermal matrix graft was also placed to increase soft tissue thickness around the implants. Healing was uneventful, and prosthetic rehabilitation was completed after confirmation of osseointegration. At 12-month follow-up, the implants remained stable with healthy peri-implant tissues and satisfactory aesthetic integration. **Conclusion:** The combined use of guided bone regeneration and acellular dermal matrix grafting can effectively address both bone deficiency and thin soft tissue biotype, thereby improving peri-implant tissue stability and supporting long-term implant success.

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INTRODUCTION

Dental implants have become a routine treatment option for replacing missing teeth and restoring oral function. Over the past few decades, improvements in implant design, surgical protocols, and prosthetic techniques have contributed to consistently high success rates for implant-supported restorations (1–3). Despite these advances, the presence of adequate bone and soft tissue remains essential for predictable outcomes. Following tooth extraction, the alveolar ridge undergoes physiologic remodelling that frequently results in both horizontal and vertical bone loss. The buccal cortical plate is particularly susceptible to resorption due to its thin structure and limited blood supply. Previous investigations have reported that nearly half of the ridge width may be lost within the first year after extraction (4–6). Such changes can complicate implant placement and may require augmentation procedures to restore ridge dimensions. Guided bone regeneration is widely used to manage alveolar ridge deficiencies. The technique involves the use of barrier membranes to create a protected space where bone regeneration can occur without interference from rapidly proliferating soft tissue cells (7–9). When combined with particulate bone graft materials, GBR can predictably increase ridge width and allow implant placement in areas that would otherwise be unsuitable. In addition to bone volume, peri-implant soft tissue thickness plays an important role in maintaining long-term implant stability. Thin mucosal tissues have been associated with a greater tendency toward gingival recession and crestal bone loss around implants (10–12). Consequently, soft tissue augmentation procedures are often performed to improve mucosal thickness and support peri-implant tissue health. Autogenous connective tissue grafts harvested from the palate have traditionally been considered the most reliable method for soft tissue augmentation. However, donor site morbidity and increased surgical time remain limitations of this approach. Acellular dermal matrix has emerged as an alternative graft material that eliminates the need for a secondary surgical site while providing a collagen scaffold that supports tissue integration (13–15). Recent clinical studies have emphasized the importance of addressing both hard and soft tissue deficiencies during implant therapy. Combining regenerative procedures such as GBR and soft tissue grafting may improve implant stability and enhance aesthetic outcomes, particularly in areas where ridge resorption and thin mucosa coexist (16–19). The present report describes the rehabilitation of missing maxillary premolars using dental implants placed in conjunction with guided bone regeneration and acellular dermal matrix grafting.

Case Presentation

A 42-year-old male patient reported to the Department of Oral and Maxillofacial Surgery with the chief complaint of missing teeth in the upper right posterior maxillary region. The patient complained of difficulty in mastication and dissatisfaction with the functional and aesthetic appearance of the edentulous space. The teeth had been extracted several months earlier due to extensive carious destruction and poor prognosis. The patient's medical history was non-contributory. He reported no history of systemic diseases such as diabetes mellitus, hypertension, or bleeding disorders. The patient was not under any long-term medication and had no known drug allergies. He was a non-smoker and maintained satisfactory oral hygiene. Intraoral clinical examination revealed an edentulous space corresponding to the maxillary first and second premolars in the right quadrant (teeth 14 and 15). The edentulous ridge appeared moderately resorbed with reduced buccopalatal width. The mucosal tissue overlying the ridge exhibited a thin gingival phenotype with minimal keratinized tissue. The adjacent teeth were clinically healthy with no evidence of periodontal disease, mobility, or periapical pathology. Radiographic evaluation was performed using cone beam computed tomography (CBCT) to assess bone volume and anatomical limitations. CBCT analysis demonstrated horizontal ridge deficiency in the edentulous premolar region. The Bucco palatal ridge width measured approximately 4.2 mm, which was insufficient for ideal implant placement. The vertical bone height was adequate, measuring approximately 12–13 mm from the alveolar crest to the maxillary sinus floor. The buccal cortical plate appeared thin, confirming the presence of horizontal ridge deficiency. No pathological changes were observed in the surrounding structures, and the maxillary sinus appeared normal. Based on the clinical and radiographic findings, implant-supported prosthetic rehabilitation was planned. Considering the reduced ridge width and thin soft tissue phenotype, simultaneous guided bone regeneration (GBR) and acellular dermal matrix (ADM) grafting were planned to augment both hard and soft tissues. The treatment plan, surgical procedure, potential complications, and expected outcomes were explained to the patient, and written informed consent was obtained before treatment.

Figure 1. Pre-operative edentulous space (14, 15)

Figure 2. Intra-operative placement of two implants

Surgical Procedure: The surgical procedure was performed under strict aseptic conditions. Local anaesthesia was achieved using 2% lidocaine with 1:100,000 epinephrine administered through buccal and palatal infiltrations.

Figure 3. Particulate xenograft bone substitute (deproteinized bovine bone mineral)

Figure 4. Postoperative closure with 3.0 black braided silk sutures

A mid-crestal incision was made along the edentulous ridge with minimal vertical releasing incisions to provide adequate surgical access while preserving vascular supply to the flap. A full-thickness mucoperiosteal flap was carefully elevated to expose the underlying alveolar ridge and evaluate the bone morphology. Sequential osteotomy preparation was performed following the drilling protocol recommended by the implant manufacturer under copious sterile saline irrigation.

Two endosseous titanium dental implants (4.0 mm diameter × 11.5 mm length) were placed in the maxillary premolar region in a prosthetically driven position.

Primary stability was achieved for both implants with an insertion torque of approximately 35 Ncm, indicating adequate primary mechanical stability. Following implant placement, a buccal bone defect was observed due to horizontal ridge deficiency. To reconstruct the deficient ridge contour, guided bone regeneration (GBR) was performed. A particulate xenograft bone substitute (deproteinized bovine bone mineral) was carefully adapted and packed over the buccal aspect of the implant sites to restore ridge volume. The graft material was then covered with a resorbable collagen membrane to stabilize the graft and prevent soft tissue infiltration into the regenerative site.

To enhance peri-implant soft tissue thickness and improve long-term tissue stability, an acellular dermal matrix (ADM) graft was placed over the implant region beneath the mucoperiosteal flap. The ADM graft was trimmed and adapted carefully to the recipient site to ensure close contact with the underlying tissues. The graft acted as a scaffold for cellular infiltration and vascularization, thereby facilitating soft tissue regeneration and increasing mucosal thickness around the implants. After placement of the graft materials, the mucoperiosteal flap was repositioned and sutured using 3.0 black braided silk sutures, non-resorbable interrupted sutures to achieve tension-free primary closure.

Postoperative medications included

- Amoxicillin 500 mg three times daily for 5 days
- Ibuprofen 400 mg as needed for pain control
- 0.12% chlorhexidine mouth rinse twice daily for 1 week

The patient was instructed to maintain good oral hygiene and avoid trauma to the surgical area. The patient was recalled after 7 days for suture removal, and clinical evaluation demonstrated satisfactory healing without signs of infection, wound dehiscence, or membrane exposure.

Figure 5. Radiographic image showing osseointegration of both implants with stable crestal bone levels.

Prosthetic Rehabilitation

Following a healing period of approximately four months, the patient returned for evaluation of implant integration. Clinical examination revealed healthy peri-implant soft tissues with increased mucosal thickness and absence of inflammation. The surgical site demonstrated good tissue contour and satisfactory healing. Radiographic examination confirmed successful osseointegration of both implants, with stable crestal bone levels around the implant fixtures. Healing abutments were placed to allow proper maturation of the peri-implant soft tissues and development of an appropriate emergence profile. After adequate soft tissue healing, prosthetic impressions were obtained using an open-tray impression technique to accurately record the implant positions.

Figure 6. Healing abutments placed at 4 months

The impressions were sent to the dental laboratory for fabrication of definitive prosthetic restorations. Implant-supported zirconia crowns were selected due to their favourable mechanical properties, excellent biocompatibility, and superior aesthetic characteristics. The prosthetic restorations were designed to achieve proper occlusion, optimal emergence profile, and harmonious integration with adjacent teeth.

Figure 7. Implant abutments are placed after soft tissue maturation and open-tray impression recording

Figure 8. Delivery of implant-supported zirconia crowns with proper occlusion and aesthetic integration

The zirconia crowns were subsequently delivered and secured onto the implants.

Clinical evaluation confirmed:

- Satisfactory occlusion
- Proper proximal contacts
- Natural esthetical integration with adjacent dentition

Post-prosthetic follow-up visits were conducted to monitor implant stability and peri-implant tissue health. At the 12-month follow-up, the implants remained clinically stable with healthy peri-implant mucosa, absence of inflammation, and stable crestal bone levels. The patient reported significant improvement in masticatory efficiency and expressed satisfaction with both the functional and aesthetic outcomes of the treatment.

DISCUSSION

Dental implant therapy has become one of the most reliable and widely accepted treatment modalities for the rehabilitation of partially or completely edentulous patients. Long-term clinical studies have consistently reported high survival rates for implant-supported restorations when proper surgical planning and prosthetic principles are followed (1–3). However, successful implant therapy depends not only on the achievement of osseointegration but also on the establishment of a stable peri-implant environment that includes adequate bone volume and healthy surrounding soft tissues. Following tooth extraction, the alveolar ridge undergoes a series of physiologic remodelling processes that often lead to significant dimensional changes. These alterations are largely attributed to the resorption of bundle bone, which previously supported the periodontal ligament of the extracted tooth. Without functional stimulation, this bone undergoes rapid remodelling, resulting in horizontal and vertical ridge reduction. Previous investigations have reported that up to 40–60% of alveolar ridge width may be lost within the first year after tooth extraction, with the majority of resorption occurring within the first three months (4–6). These changes may significantly compromise implant placement, particularly in the anterior and premolar regions where the buccal cortical plate is typically thin. Loss of buccal bone thickness presents a particular challenge in implant dentistry because it may result in unfavourable implant positioning or inadequate support for peri-implant soft tissues. When ridge width is insufficient, clinicians may be forced to place implants more palatal than ideal, which can negatively affect prosthetic emergence profile and aesthetic outcomes. Furthermore, insufficient buccal bone thickness has been associated with increased risk of marginal bone loss and soft tissue recession around implants. For these reasons, ridge augmentation procedures are frequently performed to reconstruct deficient alveolar ridges and create a more favourable foundation for implant placement. Guided bone regeneration has become one of the most widely utilized techniques for the reconstruction of alveolar ridge defects. The biological basis of GBR relies on the principle of selective cell repopulation, in which barrier membranes prevent the migration of epithelial and connective tissue cells into the defect site while allowing osteogenic cells to populate the regenerative area (7–9). By creating a protected space for bone formation, GBR facilitates the regeneration of new bone and enables successful implant placement in areas with insufficient ridge dimensions. Particulate bone graft materials are commonly used in conjunction with barrier membranes during GBR procedures. These graft materials act as osteoconductive scaffolds that support new bone formation while maintaining space beneath the membrane. Collagen membranes are frequently used because of their favourable biocompatibility, resorbable nature, and ability to stabilize graft materials during the healing process.

Numerous clinical studies have demonstrated the predictability of guided bone regeneration in increasing alveolar ridge width. Urban and colleagues reported significant horizontal ridge augmentation following GBR procedures using particulate bone grafts combined with resorbable collagen membranes, highlighting the reliability of this technique in implant site development (2). Similarly, systematic reviews have confirmed that GBR can effectively restore deficient alveolar ridges and facilitate implant placement in anatomically compromised areas (3). While adequate bone volume is essential for implant stability, the role of peri-implant soft tissues has gained increasing attention in recent years. The concept of the peri-implant phenotype emphasizes the importance of mucosal thickness, keratinized tissue width, and soft tissue quality in maintaining peri-implant health. Thin mucosal phenotypes have been associated with increased susceptibility to gingival recession, peri-implant mucositis, and marginal bone loss (10–12). In contrast, thicker peri-implant mucosa may provide a more stable biological seal around implants and contribute to improved long-term outcomes. The relationship between soft tissue thickness and marginal bone stability has been widely investigated. Studies have suggested that implants placed in sites with thin mucosal tissues may exhibit greater crestal bone loss during the early stages of healing compared with implants surrounded by thicker soft tissues. One proposed explanation for this phenomenon involves the establishment of the supracrestal tissue attachment around implants, often referred to as the peri-implant biologic width. When mucosal tissues are thin, bone remodelling may occur in order to establish an adequate soft tissue seal around the implant–abutment interface. soft tissue augmentation during implant placement. Guided bone regeneration was performed to reconstruct the buccal bone deficiency, while acellular dermal matrix grafting was used to increase peri-implant mucosal thickness.

Clinical Timeline of Treatment

Stage / Visit	**Procedure Performed**	**Clinical Outcome**
Initial Visit	Patient evaluation, including clinical examination and cone beam computed tomography (CBCT) imaging	Horizontal ridge deficiency identified in the maxillary premolar region
Treatment Planning	Implant-supported rehabilitation planned with simultaneous guided bone regeneration (GBR) and acellular dermal matrix (ADM) grafting	Multidisciplinary regenerative approach selected
Surgical Procedure	Placement of two endosseous implants with simultaneous GBR using particulate bone graft and resorbable membrane; ADM graft placed for soft tissue augmentation	Adequate primary stability was achieved with successful hard and soft tissue augmentation
1-Week Follow-up	Suture removal and postoperative evaluation	Uneventful healing with no signs of infection or graft exposure
4-Month Follow-up	Clinical and radiographic assessment of implants; placement of healing abutments	Successful osseointegration confirmed
Prosthetic Phase	Prosthetic impressions taken; fabrication and delivery of implant-supported zirconia crowns	Functional occlusion and satisfactory aesthetic integration achieved
12-Month Follow-up	Clinical and radiographic evaluation of implants and peri-implant tissues	Stable implants with healthy peri-implant tissues and satisfactory functional outcomes

Increasing mucosal thickness through soft tissue augmentation procedures may therefore help preserve marginal bone levels and improve peri-implant stability. Soft tissue augmentation procedures are frequently performed to enhance peri-implant mucosal thickness and improve aesthetic outcomes. Autogenous connective tissue grafts harvested from the palate have traditionally been considered the gold standard technique for increasing soft tissue volume around implants. These grafts provide excellent biological compatibility and predictable clinical outcomes. However, harvesting connective tissue grafts requires a secondary surgical site, which may increase surgical morbidity, postoperative discomfort, and operative time. In recent years, alternative biomaterials have been developed to reduce the need for autogenous graft harvesting. Among these materials, acellular dermal matrix has gained widespread use in periodontal and implant surgery. ADM is derived from processed human dermis in which cellular components are removed while preserving the extracellular collagen framework. This matrix provides a scaffold that supports cellular infiltration, angiogenesis, and tissue regeneration after implantation (13–15).

The use of ADM offers several advantages over autogenous connective tissue grafts. Because ADM does not require harvesting from a donor site, it eliminates donor-site morbidity and reduces postoperative discomfort for the patient. Additionally, ADM can be easily adapted to the recipient site and provides a stable matrix for soft tissue regeneration. Clinical studies have demonstrated favourable outcomes with ADM in peri-implant soft tissue augmentation. Investigations have reported increases in mucosal thickness, improved gingival contour, and enhanced aesthetic integration of implant restorations following ADM grafting. In certain clinical scenarios, ADM has demonstrated outcomes comparable to those achieved with autogenous connective tissue grafts, particularly when used to increase mucosal thickness around implants (13–15). Another important consideration in implant therapy is the impact of peri-implant soft tissue thickness on long-term bone stability. Linkevicius and Apse reported that implants surrounded by thicker mucosal tissues exhibited less crestal bone loss compared with implants placed in sites with thin mucosa (7). These findings support the concept that increasing mucosal thickness may help establish a more stable biological environment around implants. The present case demonstrates the clinical application of simultaneous hard and Addressing both bone and soft tissue deficiencies during the same surgical procedure may provide several advantages. Simultaneous augmentation procedures can reduce overall treatment time and minimize the need for multiple surgical interventions. In addition, the presence of both adequate bone support and thicker mucosal tissues may create a more favourable biological environment for implant osseointegration and long-term stability. Another factor contributing to the favourable outcome observed in this case was the achievement of adequate primary implant stability. Primary stability plays a crucial role in successful osseointegration and is influenced by factors such as bone quality, implant design, and surgical technique. In the present case, careful osteotomy preparation and appropriate implant placement allowed sufficient primary stability to be achieved, thereby promoting predictable healing. The prosthetic phase of implant therapy is equally important in achieving long-term success. Proper prosthetic design ensures favourable load distribution and minimizes excessive mechanical stress on the implant and surrounding bone. In this case, implant-supported zirconia crowns were selected due to their favourable mechanical strength, biocompatibility, and aesthetic characteristics.

Zirconia restorations have gained popularity in implant prosthodontics because they offer excellent aesthetic properties and high fracture resistance. Furthermore, zirconia materials demonstrate low plaque accumulation and favourable tissue response, which may contribute to improved peri-implant soft tissue health. Occlusal design is another critical factor in maintaining implant stability. Proper occlusal relationships help distribute functional forces evenly across the prosthesis and reduce excessive loading of the implant fixture. In the present case, careful occlusal adjustment ensured harmonious contact with the opposing dentition and minimized biomechanical stress on the implants. Long-term follow-up is essential for evaluating implant success. Regular clinical and radiographic examinations allow early detection of potential complications such as peri-implant mucositis, peri-implantitis, or prosthetic failures. In this case, follow-up evaluation at twelve months demonstrated stable peri-implant tissues, absence of inflammation, and satisfactory prosthetic function. Despite the favourable outcome observed in this case, certain limitations should be acknowledged. Case reports represent a relatively low level of evidence and cannot establish definitive conclusions regarding treatment effectiveness. Nevertheless, they provide valuable clinical insights and contribute to the existing body of knowledge by illustrating practical applications of regenerative techniques in implant therapy. Future research should focus on long-term clinical trials evaluating the stability of combined hard and soft tissue augmentation procedures. Additionally, comparative studies examining ADM grafts and autogenous connective tissue grafts may further clarify their respective roles in peri-implant soft tissue management. Overall, the present case highlights the importance of comprehensive treatment planning in implant rehabilitation. By addressing both alveolar bone deficiency and soft tissue limitations simultaneously, clinicians can establish a more favourable peri-implant environment that supports successful osseointegration and long-term implant stability. The integration of regenerative techniques such as guided bone regeneration and acellular dermal matrix grafting represents a valuable multidisciplinary approach in modern implant dentistry. When applied appropriately, these procedures can significantly enhance both functional and aesthetic outcomes in patients requiring implant-supported rehabilitation.

Future Perspectives in Implant Regenerative Surgery

Advances in regenerative dentistry have significantly expanded the therapeutic possibilities available for implant rehabilitation. Over the past two decades, the development of biomaterials, growth factors, and tissue engineering techniques has transformed the management of alveolar ridge deficiencies. The integration of these technologies into implant dentistry continues to improve clinical outcomes and expand treatment options for patients with complex anatomical limitations. One of the most promising areas of future research in implant regenerative surgery involves the development of next-generation biomaterials designed to enhance both bone and soft tissue regeneration. Novel barrier membranes with improved biocompatibility and resorption profiles are being developed to optimize guided bone regeneration procedures. These materials aim to improve membrane stability, reduce infection risk, and enhance osteogenic potential. Another important direction in regenerative implant dentistry is the incorporation of biologically active molecules such as growth factors and platelet concentrates. Platelet-rich fibrin (PRF), platelet-rich plasma (PRP), and recombinant growth factors have demonstrated promising results in enhancing angiogenesis, bone formation, and soft tissue healing. Future studies may further clarify the role of these biologic adjuncts in combination with bone grafts and soft tissue substitutes.

Tissue engineering approaches involving stem cell therapy and scaffold-based regeneration are also gaining attention in implant dentistry. Mesenchymal stem cells have shown potential for promoting bone regeneration in alveolar defects, and their integration with biomaterial scaffolds may lead to improved regenerative outcomes in the future. Digital technologies are another rapidly evolving field influencing implant therapy. The use of digital planning, cone-beam computed tomography, and computer-guided implant surgery allows clinicians to achieve highly accurate implant placement while minimizing surgical trauma. These technologies may also facilitate better integration of regenerative procedures with implant placement. Artificial intelligence and advanced imaging analysis are also expected to play an increasing role in implant treatment planning. These tools may assist clinicians in predicting bone remodelling patterns, evaluating tissue quality, and optimizing implant positioning for long-term stability. Furthermore, future research will likely focus on improving the long-term stability of soft tissue graft substitutes such as acellular dermal matrix. While current studies have demonstrated favourable outcomes, long-term clinical trials are necessary to evaluate the durability of these materials in peri-implant tissue augmentation. The integration of regenerative biomaterials, biologic agents, and digital technologies represents the next frontier in implant dentistry. These advancements may enable clinicians to manage increasingly complex cases while improving patient outcomes and reducing treatment time. In conclusion, the continued evolution of regenerative techniques will likely expand the role of multidisciplinary approaches in implant therapy. Combining guided bone regeneration, soft tissue graft substitutes, and advanced digital technologies may significantly enhance the predictability and aesthetic outcomes of implant-supported rehabilitation in the future.

CONCLUSION

This case report demonstrates the successful rehabilitation of missing maxillary premolars using dental implants combined with guided bone regeneration and acellular dermal matrix grafting. The simultaneous management of hard tissue deficiency and soft tissue augmentation played a critical role in achieving stable peri-implant tissues and favourable aesthetic outcomes. A multidisciplinary approach incorporating regenerative techniques such as GBR and ADM can significantly enhance implant success in cases involving alveolar ridge deficiencies. Careful treatment planning, precise surgical technique, and appropriate biomaterial selection are essential for achieving predictable functional and aesthetic results in implant dentistry.

Ethical Statement: Written informed consent was obtained from the patient for treatment and publication of this case report and accompanying images.

Author Contributions: Dr. G.V. Reddy (MDS, Oral and Maxillofacial Surgery, HOD and Professor) and Dr. M. R. Haranadha Reddy (Professor, Oral and Maxillofacial Surgery) contributed to the conceptualization and overall design of the study, provided senior clinical supervision, validated the surgical protocol, and guided the preparation of the manuscript to ensure scientific accuracy and clinical relevance. Dr. Sarah Fatima (MDS, Oral and Maxillofacial Surgery, Professor) and Dr. Thudimilla Shivani (Postgraduate II year, MDS, Oral and Maxillofacial Surgery) were primarily responsible for the surgical management of the case, supervised the clinical procedures, contributed to data acquisition and interpretation, and played a major role in drafting and critically revising the manuscript for important intellectual content. Dr. Boddhireddy Nikita, Dr. K. Sri Bhavya, and Dr. Ampelly Rishitha (BDS) contributed to data collection, clinical documentation, patient follow-up, and preparation of the initial manuscript draft, as well as assisting in the literature review and organization of the clinical data presented in the case report. Dr. Soniya Chavan, Dr. V. Anjani, Dr. Ayesha Sultana, Dr. Amena Asif, Dr. Lasya SNKP Duggirala, and Dr. Israa Mohammed Younus (BDS) contributed to data compilation, preparation of clinical records, and assistance in manuscript editing and formatting. All authors reviewed the final manuscript, approved the submitted version, and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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