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Research Article

Biologically driven regenerative management of an unusual buccal defect associated with a foreign body using enamel matrix derivative

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Abstract

Periodontal regeneration remains a primary objective in the management of periodontal defects, aiming to restore lost tissues such as alveolar bone, root cementum, and the periodontal ligament. Biologically guided approaches have enhanced treatment predictability by harnessing the molecular mechanisms of wound healing, with enamel matrix derivatives (EMD) representing a key biomimetic tool capable of supporting true periodontal regeneration. This article describes the application of a biologically driven regenerative strategy using Emdogain® in the management of an unusual buccal defect associated with a foreign body. The treatment, based on minimally invasive principles and biologically oriented wound stabilization, resulted in favorable clinical healing and radiographic evidence of new bone formation and re-establishment of the periodontal space. The observed defect resolution underscores the regenerative capacity of enamel matrix derivatives and highlights their value as reliable materials within contemporary biologically guided periodontal therapy.

Keywords

Buccal dehiscence, enamel matrix derivative, foreign body, periodontal regeneration, tissue healing

Introduction

Periodontal regeneration is defined as the biological reconstitution of periodontal structures lost due to disease or trauma, specifically involving the coordinated formation of new alveolar bone, new cementum, and a functionally oriented periodontal ligament (PDL) inserting into the root surface. Contemporary investigations have emphasized that true regeneration requires the re-establishment of the highly specialized architecture of the PDL, including its complex collagen fiber orientation, vascular network, and mechanosensory components—features essential for restoring functional biomechanics (de Jong et al. 2017). Advances in developmental biology and tissue engineering further highlight that regeneration is contingent upon recapitulating aspects of PDL development, including the crosstalk between ligament fibroblasts, cementoblasts, and osteoblasts, as well as the spatial organization of Sharpey's fibers (de Jong et al. 2017). The integration of biomimetic scaffolds, stem/progenitor cells, and bioactive cues has demonstrated promising capacity to reconstruct the bone–ligament–cementum complex, as shown in recent clinical studies (Liu et al. 2019). Despite this progress, several challenges remain, particularly in achieving predictable three-dimensional regeneration of complex defects, controlling wound stability, ensuring adequate vascularization, and guiding cell–matrix interactions within the periodontal apparatus. Emerging strategies in guided tissue regeneration now include sophisticated scaffold designs, growth factor delivery systems, and cell-based approaches aimed at overcoming these limitations (Liu et al. 2022). From a clinical perspective, the shift toward precision regenerative therapy has been further supported by new treatment-oriented classifications of osseous defects, which enable clinicians to match defect morphology with the most suitable regenerative modality. These modern classification systems underscore the multidimensional nature of regenerative decision-making and reinforce the need for anatomically guided surgical approaches (Nibali and Cortellini 2025).

Within this evolving regenerative framework, biologically active proteins capable of mimicking periodontal development have gained considerable attention, with enamel matrix derivative (EMD) emerging as one of the most extensively studied biomaterials. Over the past three decades, EMD has been conceptualized as a biologically informed attempt to replicate key events of cementogenesis and periodontal ligament formation, thereby promoting true regeneration rather than repair. This developmental rationale has been comprehensively articulated in recent high-level analyses, including the 30-year overview by Miron et al. (2025) and the contemporary narrative review by Xiang et al. (2025), both of which emphasize EMD's capacity to modulate cell behavior, enhance wound stability, and orchestrate periodontal tissue formation.

Earlier foundational work, such as the 20-year synthesis presented by Miron et al. (2016), established the mechanistic basis for EMD's clinical efficacy, demonstrating its influence on cementoblasts, periodontal ligament fibroblasts, and osteogenic lineage cells. Subsequent molecular and cell-based studies further refined this understanding. For instance, Amin et al. (2016) elucidated the interactions between enamel matrix proteins and human periodontal ligament cells, highlighting their role in promoting proliferation, attachment, and matrix synthesis—processes that align closely with the biological requirements for functional regeneration. More recent insights, such as those summarized by Shu and Lin (2023), underscore the continuing evolution of EMD research and advocate for a renewed interpretation of enamel matrix proteins as complex signaling entities essential for orchestrating periodontal tissue reconstruction.

Materials and methods

A 24-year-old female, a non-smoker, and systemically healthy, presented with a chief complaint of recurrent swelling in the region of the mandibular right second premolar. The patient reported that the initial symptoms began acutely following the consumption of whole-grain bread, which resulted in sharp, localized pain and further discomfort in the affected area. Within several days, the discomfort progressed to a noticeable swelling accompanied by purulent exudation (Fig. 1). According to the patient's history, she initially sought dental care shortly after the onset of symptoms. At that time, drainage of the purulent content was performed, resulting in temporary symptomatic relief (Fig. 2). However, despite the intervention, the swelling recurred intermittently, with each episode associated with renewed suppuration from the same region. The persistence of symptoms prompted further consultation, during which empirical antibiotic therapy and endodontic treatment of the involved tooth were recommended.

Figure 1. Clinical presentation of a purulent abscess in the area of the maxillary left second premolar.

Figure 2. Post-evacuation appearance several days after purulent exudate drainage.

Given the recurrent nature of the swelling and the absence of sustained clinical improvement, the patient sought a second opinion at a private periodontal practice. Several days prior to the consultation, the patient submitted a self-captured intraoral photograph that demonstrated evidence of a chronic fistulization tract in the region of the mandibular right second premolar (Fig. 3). A comprehensive clinical examination raised the suspicion of an underlying pathology not fully explained by a purely endodontic origin. Consequently, advanced imaging was deemed necessary, and a cone-beam computed tomography (CBCT) scan of the region was requested to better characterize the extent and nature of the lesion.

Figure 3. Presence of a fistulous tract localized within the keratinized gingiva.

Electric pulp testing (EPT) was performed and confirmed a normal vitality response of the mandibular right second premolar. Cone-beam computed tomography subsequently revealed a pronounced buccal bone dehiscence in the affected region, as well as the presence of a radiopaque foreign body intimately associated with the most apical part of the anatomical bone dehiscence of the second premolar (Fig. 4).

Given the confirmed vitality of the tooth, an endodontic etiology was considered unlikely, and the decision to proceed with periodontal surgical management was discussed with the patient. Prior to surgical intervention, the patient underwent non-surgical periodontal therapy (Step 1) aimed at reducing local inflammation and optimizing the soft-tissue condition. Once satisfactory oral hygiene and adequate inflammatory control were achieved, the patient was scheduled for definitive surgical intervention. The uncertain etiology of the lesion was discussed in detail with the patient, together with all procedural steps outlined in the planned surgical protocol. The patient provided full agreement to the proposed management and signed an informed consent form prior to the intervention. Under local anesthesia, a split–full–split mucoperiosteal flap was performed following the Zucchelli design to ensure optimal access and preservation of the marginal tissues (Zucchelli et al. 2015). Upon flap reflection, the underlying anatomy revealed a clearly delineated buccal bone dehiscence. Following meticulous inspection and thorough lavage of the defect, a black-pigmented particulate fragment—consistent with a foreign body—was dislodged and inadvertently aspirated through the suction system before it could be mechanically retrieved for analysis. The defect was gently and selectively debrided with atraumatic mechanical instrumentation to remove granulation tissue while deliberately avoiding unnecessary over-instrumentation of the root surface (Zucchelli and De Sanctis 2000). PrefGel® was subsequently applied to the root surface for 2 minutes, after which Emdogain® was carefully placed into the defect according to the manufacturer's protocol after careful root planing until the clinical attachment loss was measured. The flap was secured with 6-0 absorbable monofilament sutures to ensure stable soft-tissue adaptation and stable primary closure (Figs 5–8). CBCT assessment demonstrated regeneration of the buccal alveolar bone and re-establishment of a discernible periodontal ligament space, consistent with radiographic evidence of periodontal regeneration (Fig. 9). At the 18-month follow-up, the site exhibited no pathological probing depths and maintained a clinically stable soft-tissue architecture (Fig. 10). Mild bleeding on scaling was noted, attributable to suboptimal oral hygiene practices in the treated area, and the patient was consequently advised to improve daily oral hygiene measures.

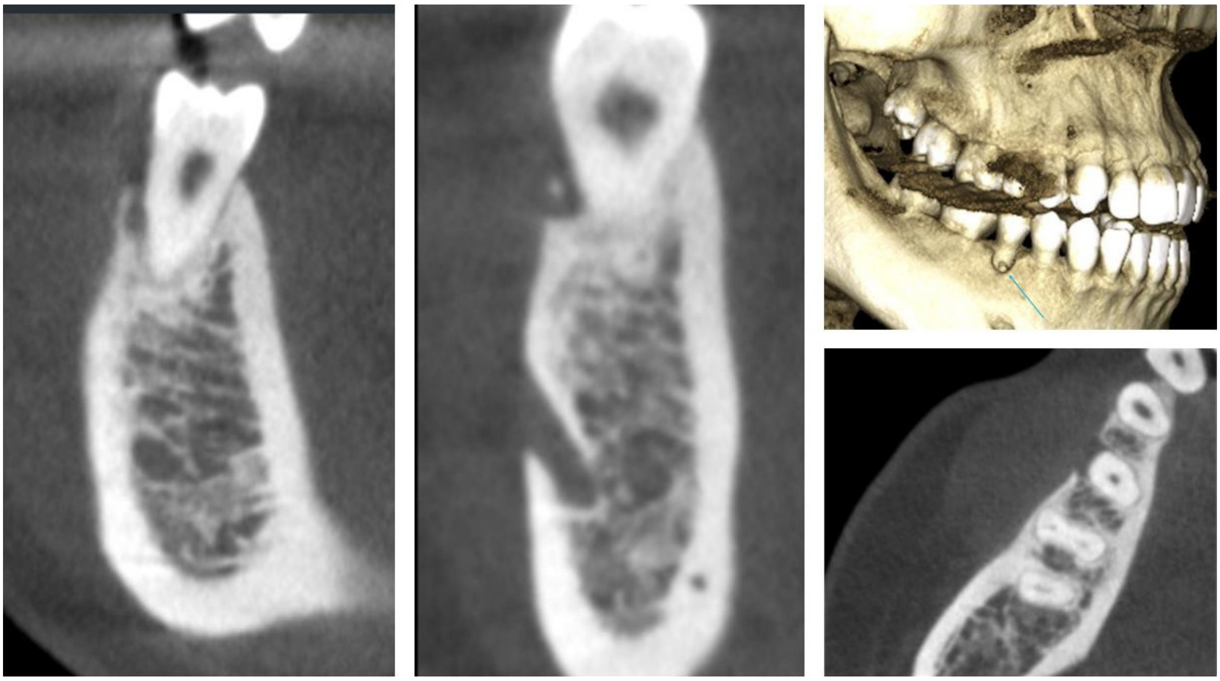

Figure 4. Detection of a foreign body associated with the region of interest based on CBCT evaluation.

Figure 5. Clinical presentation prior to surgery, documented after Step 1 periodontal therapy.

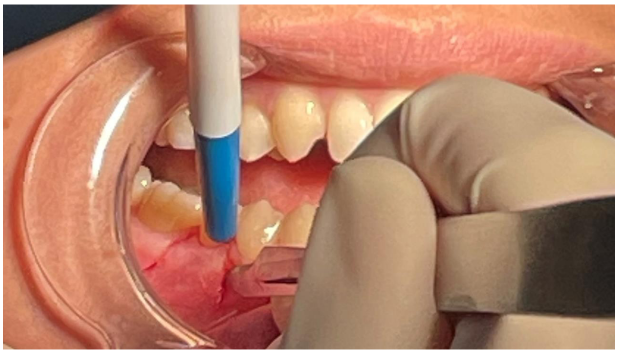

Figure 6. Surgical flap design.

Figure 7. Measured 7 mm clinical attachment loss with a corresponding 5 mm bone dehiscence depth.

Figure 8. Coronal repositioning and suturing of the surgical flap.

Discussion

Periodontal regeneration continues to evolve as new biologically active materials and refined surgical protocols expand the range of treatable clinical scenarios. Enamel matrix derivative (Emdogain®), in particular, has remained central to regenerative periodontal therapy due to its capacity to modulate early wound healing, stimulate periodontal ligament and cementoblast activity, and support the initiation of new attachment formation. Recent analyses have reinforced these biologic principles, showing that EMD enhances tissue maturation, angiogenesis, and matrix deposition—key aspects of periodontal wound stability and regeneration (Tamzini et al. 2022). These effects reflect the broader developmental roles of enamel

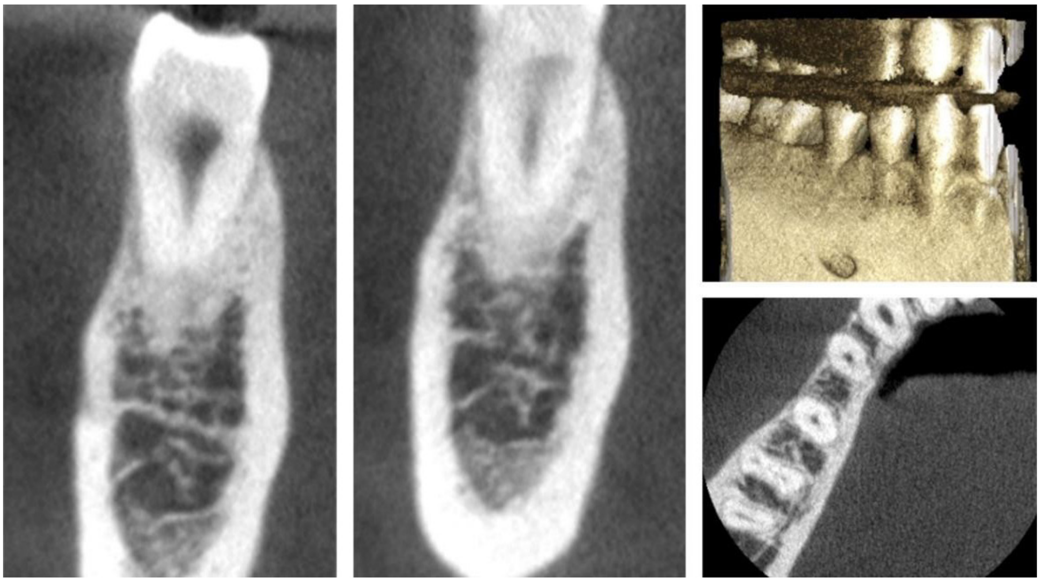

Figure 9. CBCT findings consistent with regeneration of the buccal bone and presence of periodontal ligament space.

Figure 10. Clinical follow-up at 18 months.

and dentin organic matrices, which orchestrate mineralized tissue formation and regulate cell signaling during tooth development, as highlighted by Jiang et al. (2022).

Systematic evaluations of regenerative outcomes have further demonstrated that EMD remains clinically relevant across a range of intrabony defect morphologies, improving clinical attachment levels and radiographic parameters even in anatomically challenging presentations (Bud et al. 2025). Similarly, contemporary reviews of tissue regeneration emphasize that regenerative outcomes rely on the integration of biologically active materials with meticulous surgical execution, particularly in defects where soft-tissue stability and vascular support are critical for predictable healing (Nedelkovska et al. 2024). At the same time, documented cases of treatment failure resulting from structural compromise, including excessive dentin removal or perforation (Oda et al. 2022), underscore the necessity of preserving or re-establishing optimal tissue architecture during regenerative procedures.

Within this broader scientific and clinical context, the present case—characterized by a buccal dehiscence and a retained foreign-body particle associated with a vital mandibular second premolar—illustrates a complex periodontal condition requiring both biologic stimulation and precise soft-tissue management. The choice to employ EMD in conjunction with a split–full–split (Zucchelli-style) flap was guided by the need to create a stable, well-vascularized surgical environment capable of supporting the regenerative potential of enamel matrix proteins. This combined approach reflects current understanding that successful regeneration depends not only on biologically active agents but also on achieving tension-free coronal advancement, robust blood supply, and early wound protection—all essential determinants for restoring the bone–ligament–cementum complex in non-standard periodontal defects. The combination of enamel matrix derivative with a mucogingival approach offers a biologically synergistic environment for periodontal regeneration, particularly in cases involving buccal dehiscence defects. EMD provides a biomimetic stimulus that recapitulates key stages of periodontal development by promoting cementogenesis, modulating periodontal ligament fibroblast activity, and enhancing early wound stability through its intrinsic protein matrix. These biologic effects are optimally expressed in a surgical milieu that ensures tension-free flap adaptation, stable primary closure, and adequate blood supply—criteria inherently met by the Zucchelli flap design (Zucchelli et al. 2015). The split–full–split architecture preserves the supraperiosteal vascular plexus, thereby enhancing perfusion to the coronally advanced tissues, while the full-thickness segment ensures precise access and visualization of the defect for biomaterial placement (Cairo et al. 2012). The controlled coronal advancement achieved through this technique creates a protected microenvironment that minimizes micromotion, a prerequisite for the periodontal ligament–mediated regenerative cascade initiated by EMD. Together, these combined biologic and surgical principles create an optimized wound environment conducive to the coordinated formation of new cementum, functionally oriented periodontal ligament fibers, and alveolar bone—fulfilling the core requirements for true periodontal regeneration. Studies on coronally advanced flap dynamics, including those by Cairo et al. (2012) and Stefanini et al. (2018), reinforce the critical importance of flap stability and vascular integrity in promoting biologically driven periodontal regeneration. Together, these biologic and surgical principles act synergistically to support the coordinated formation of new cementum, functionally oriented periodontal ligament fibers, and alveolar bone.

Conclusion

This case highlights the critical role of precise diagnosis and individualized regenerative planning in the management of atypical periodontal lesions. By recognizing a foreign-body–associated buccal dehiscence in the presence of maintained pulpal vitality, treatment was redirected away from unnecessary endodontic therapy toward a periodontal regenerative approach capable of restoring periodontal architecture. The successful outcome achieved with enamel matrix derivative and a mucogingival approach reinforces the value of combining biologically active agents with soft-tissue designs that safeguard wound stability and enhance the regenerative potential of the surgical site.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statements

The authors declared that no clinical trials were used in the present study.

The authors declared that no experiments on humans or human tissues were performed for the present study.

Informed consent from the humans, donors or donors' representatives: Faculty of Dental Medicine.

The authors declared that no experiments on animals were performed for the present study.

The authors declared that no commercially available immortalised human and animal cell lines were used in the present study.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
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Data availability

All of the data that support the findings of this study are available in the main text.

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