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Original Research Article

Minimally Invasive Regenerative Management of an Anterior Intraosseous Defect Using Moldable Xenograft: A Case Report

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Abstract: ***Introduction:*** Advanced periodontal bone defects compromise tooth stability and represent a major therapeutic challenge. Current regenerative concepts focus on minimally invasive surgical approaches combined with bioactive graft materials to improve healing while minimizing tissue trauma. Xenogeneic bone substitutes incorporating hydrogel carriers have recently gained interest due to their enhanced handling properties and biological performance. ***Case Presentation:*** A 22-year-old healthy female presented with progressive spacing and mobility in the maxillary anterior region.Periodontal examination revealed a 6-mm probing depth with Grade II mobility on the mesial surface of the right maxillary central incisor, without gingival recession. Radiographic assessment showed a vertical intraosseous defect extending to the middle third of the root. ***Intervention:*** Following non-surgical periodontal therapy and stabilization of the involved tooth, regenerative surgery was performed using a minimally invasive approach with a bovine cancellous xenograft under magnification. Buccal access permitted meticulous defect debridement while preserving the soft-tissue architecture. A moldable deproteinized bovine cancellous xenograft embedded in a hydrogel matrix was placed to fill the defect, providing graft stability and promoting vascular infiltration. The flap was repositioned and secured with internal sutures. ***Outcome and Conclusion:*** Postoperative healing was uncomplicated. Six-month follow-up demonstrated a 4-mm reduction in probing depth, equivalent clinical attachment gain, and radiographic evidence of bone regeneration. This report supports the clinical usefulness of minimally invasive periodontal surgery combined with advanced xenograft biomaterials for predictable regenerative outcomes.

Keywords: Periodontal regeneration, Intraosseous periodontal defect, Minimally invasive periodontal surgery, Xenogeneic bone graft

INTRODUCTION

Periodontal osseous defects reflect advanced periodontal breakdown and are closely linked to disease severity and long-term tooth prognosis. Appropriate management of these defects plays a critical role in arresting further tissue destruction and enabling regeneration of the lost periodontal supporting structures[1].

Over the past two decades, the evolution of Minimally Invasive Periodontal Surgery (MIPS) has markedly transformed the regenerative management of intraosseous defects.[2]

Owing to the complex anatomy of the interdental area and the morphology of intraosseous defects, conventional periodontal regenerative techniques employing marginal gingival incisions may increase the risk of early wound dehiscence, surgical site exposure, and subsequent bacterial contamination, thereby adversely affecting regenerative outcomes. Moreover, traditional surgical approaches often involve extensive flap elevation, which may result in soft-tissue collapse, compromised clot stability, increased postoperative morbidity, delayed wound healing, and esthetic complications such as gingival recession. These limitations highlight the need for simplified surgical approaches that preserve soft-tissue architecture and optimize clinical and esthetic outcomes[3].

Bone grafts are widely used in periodontal regeneration, with xenografts demonstrating favorable clinical outcomes. In the present case, a bovine cancellous xenograft with a hydrogel matrix (S1 moldable bone, 0.2–1.0 mm; MedPark Co., Ltd., Seoul, South Korea) was used, offering excellent handling characteristics and angiogenic support for predictable healing[4].

A 20-year study by Cortellini et al.[5] evaluated regenerative versus conventional flap therapy for intrabony defects. Regenerative treatments, such as the modified papilla preservation technique with ePTFE membranes, demonstrated superior long-term clinical attachment stability, fewer disease recurrences, no tooth loss, and reduced costs from re-intervention compared to conventional flap therapy. These results underscore the lasting advantages of regenerative approaches and support the use of minimally invasive techniques for managing intrabony periodontal defects.

Present article describes a clinical case in which an intraosseous defect was effectively managed using a minimally invasive surgical approach. The clinical rationale, step-by-step surgical protocol and the favourable healing response are presented to demonstrate the efficacy of this contemporary regenerative technique.

Case Presentation: A 22-year-old female patient reported to the Department of Periodontics with a chief complaint of mobility of the upper anterior teeth and spacing between the same teeth. The patient had no systemic health issues and reported a history of orthodontic treatment one year earlier. Clinical examination revealed a 1mm spacing between the maxillary central incisors, which had gradually developed over the past 6 months. Periodontal probing demonstrated a probing depth of 6 mm on the mesial aspect of the right maxillary central incisor (Figure 1), Grade II mobility was observed in the affected tooth, while the gingival tissues showed no evidence of recession.

A periapical radiograph revealed an angular defect extending up to the middle third of the root on the mesial aspect of the right maxillary central incisor (Figure 2). Considering the defect's location in an esthetically critical region, a minimally invasive regenerative periodontal procedure using a xenograft was planned before the initiation of orthodontic treatment.
The clinical findings, proposed treatment plan, and the use of a xenograft as the regenerative material were explained in detail to the patient. Following completion of Phase I periodontal therapy, composite wire splinting was performed to stabilize the involved tooth due to the presence of Grade II mobility. The benefits, potential risks, and possible complications of the procedure were discussed with the patient.

Surgical Procedure: Following completion of Phase I therapy, the patient provided written informed consent for the surgical procedure. Profound local anesthesia was achieved using 2% lignocaine hydrochloride with 1:80,000 adrenaline. Before surgery, bone sounding was performed to assess the morphology and extent of the intraosseous defect, and the surgical site was prepared under aseptic conditions. All procedures were carried out under 4.0× magnification loupes.
The interdental papilla associated with the defect was carefully accessed, and a modified minimally invasive surgical technique (M-MIST) in combination with a bovine cancellous xenograft with a hydrogel matrix (S1 moldable bone, 0.2–1.0 mm; MedPark Co., Ltd., Seoul, South Korea) was planned. A buccal incision following the modified papilla preservation technique was made on the affected tooth using a No. 15C Bard-Parker blade (Figure 3). A full-thickness buccal mucoperiosteal flap was meticulously elevated to expose the osseous defect Thorough debridement and root surface decontamination were performed to eliminate granulation tissue and establish a clean defect environment (Figure 4).

Following defect preparation, the S1 xenograft was placed to fill the intraosseous defect (Figure 5). The flap was then repositioned and stabilized using internal mattress sutures (Figure 6).

Postoperative instructions were provided and analgesics were prescribed for pain management. The patient was recalled after one week for evaluation and suture removal. At this visit, the surgical site demonstrated uneventful healing and all sutures were removed without complications.

At the three-month postoperative follow-up, the periodontal condition remained stable and healthy, after which the patient proceeded with orthodontic treatment (Figure 7). At the six-month postoperative evaluation, the surgical site appeared firm and pink, with no signs of inflammation. Clinical assessment revealed a 4-mm reduction in probing depth and a corresponding 4-mm gain in clinical attachment level (Figure 8). Radiographic evaluation showed reduced radiolucency within the intraosseous defect, indicative of progressive bone fill (Figure 9).

Figure 1: Pre-operative view demonstrating a probing depth of 6 mm on the mesial aspect of the right maxillary central incisor

Figure 2: A periapical radiograph revealed an angular defect extending up to the middle third of the root on the mesial aspect of the right maxillary central incisor.

Figure 3: A buccal incision following the modified papilla preservation technique given.

Figure 4: A full-thickness buccal mucoperiosteal flap reflection & thorough debridement.

Figure 5: S1 xenograft was placed to fill the intraosseous defect.

Figure 6: The flap was then repositioned and stabilized using internal mattress sutures.

Figure 7: At three-month postoperative follow-up.

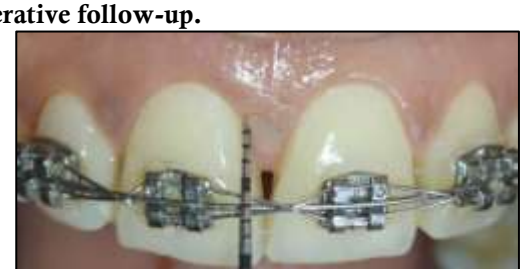

Figure 8: At the six-month postoperative evaluation, 4-mm reduction in probing depth and a corresponding 4-mm gain in clinical attachment level.

Figure 9: Radiographic evaluation showed reduced radiolucency within the intraosseous defect, indicative of

progressive bone fill.

DISCUSSION

Intrabony periodontal defects are vertical osseous lesions that may retain one, two or three bony walls. Defects with two or more residual walls generally exhibit more predictable regenerative outcomes, as the remaining walls provide lateral sources of periodontal ligament cells and enhanced vascular support, creating a favorable healing environment(6). The combination of a minimally invasive surgical approach with a biocompatible xenograft is a well-established strategy for managing such defects, resulting in significant improvements in clinical attachment level (CAL), probing depth reduction, and bone fill.

In the present case, a midline diastema was observed in association with an intraosseous defect, and the patient had undergone orthodontic treatment one year prior to presentation. Midline diastema has been attributed to multiple periodontal and biological factors, including oral habits, soft-tissue imbalances, physical impediments, active periodontal infection and dentoskeletal disharmony. Considering the multifactorial etiology of periodontitis, the localized inflammatory changes observed in this case were likely influenced by the presence of the midline diastema as well as the history of orthodontic treatment. The diastema may have facilitated chronic food impaction, thereby acting as a local etiologic factor for plaque accumulation and subsequent periodontal inflammation. Furthermore, alveolar bone loss secondary to periodontal disease may have compromised maxillary arch support, contributing to increased tooth mobility and progressive spacing(7).
The concept of minimally invasive regenerative surgery originated with the Minimally Invasive Surgical Technique (MIST) proposed by Harrel and Rees in 1995 (8) was subsequently refined by Cortellini and Tonetti to optimize tissue preservation, wound stability, and regenerative potential(9).

The M-MIST is indicated for defects accessible and debrided from the buccal aspect alone, while full MIST is recommended when buccal access is insufficient(10).

In this case, a xenograft (S1 moldable bone, 0.2–1.0 mm particle size; MedPark Co., Ltd., Seoul, South Korea) a deproteinized bovine cancellous bone integrated with a hydrogel matrix (hydroxypropyl methylcellulose) was used. Its high porosity (>70%) promotes angiogenesis and vascular ingrowth, while the cohesive hydrogel matrix enhances handling, stability and moldability. The material's inherent stickiness eliminates the need for additional binders, such as platelet-rich fibrin, and its particulate form allows precise adaptation to the defect morphology(11).

At six months postoperatively, the periodontal condition was stable with clinical assessment revealing a 4 mm reduction in probing depth and a corresponding 4 mm gain in CAL. Radiographic evaluation demonstrated progressive bone fill within the defect. These outcomes are consistent with current regenerative literature (9) and align with findings by Cortellini et al. (12) who reported that teeth with deep pockets and intrabony defects can be successfully maintained long-term using either M-MIST alone or with regenerative materials within a structured supportive periodontal care program.

Similarly, Ambrosi et al.(13) demonstrated that minimally invasive periodontal surgeries (MIPS) result in significant clinical and radiographic improvements in infrabony defect management, with mean probing depth reduction of 4.24 mm, CAL gain of 3.89 mm and radiographic bone fill of 58%, while patient-reported discomfort remains minimal.
Evidence suggests that MIPS achieves superior reductions in probing depth and CAL improvements compared with traditional flap procedures(14). Although standard clinical outcome measures such as probing, radiographs, and surgical re-entry are commonly used to assess regenerative outcomes, histologic analysis remains the only definitive method to confirm true periodontal regeneration, which was not feasible in this case.

The favorable clinical and radiographic outcomes observed in this case are likely attributable to the minimally invasive surgical technique, the biologically favorable properties of the xenograft, patient compliance with follow-up care and the absence of plaque accumulation or bleeding on probing at the treated sites. Collectively, these factors contribute to the potential long-term stability of regenerative outcomes.

The clinical and radiographic improvements observed in the present report are most likely the result of the surgical approach employed, the properties of the biomaterials selected, the patient's compliance with follow-up care, and the absence of bacterial plaque accumulation and bleeding on probing at the treated sites. These factors collectively contribute to the long-term stability of regenerative outcomes(15).

CONCLUSION

The present case demonstrates that a xenograft (S1 moldable bone, 0.2–1.0 mm particle size; MedPark Co., Ltd., Seoul, South Korea) combined with a

minimally invasive regenerative approach can achieve favorable clinical and radiographic outcomes in the management of intraosseous periodontal defects. Minimally invasive techniques offer predictable results, reduced postoperative morbidity, enhanced wound stability and superior esthetic outcomes. Early management of periodontal defects in orthodontic patients is critical to preserve periodontal support, optimize tooth movement biomechanics and prevent further disease progression.

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