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RESEARCH ARTICLE

# Complication Management in Periodontal Ligament-Mediated Implant Placement with Total Extraction of the Root: A Case Report with 4 Years Follow-up

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## ABSTRACT

An increasing number of studies report on periodontal ligament-mediated implant placement procedures to mitigate the biological sequel of total tooth extraction in the esthetic zone. Longitudinal results of these techniques show promising results for ridge dimensional stability achieved by partial extraction of the root followed by immediate implant placement. Nonetheless, because of the recency of these techniques, there is a dearth of clinical documentation of related complications and protocols for their management. In this case report, we present the management of a complication in an implant in the aesthetic zone utilizing the “root-membrane” technique with a four-year follow-up. Total extraction of the root membrane and guided bone regeneration resolved the dental-related complication.

**Keywords:** Complication management, PDL-mediated implant placement, root-membrane

## Introduction

In contemporary implant dentistry functional rehabilitation and restoration of aesthetics go hand in hand.<sup>1</sup> This stands particularly true for the anterior region of the maxillary arch, aka esthetic region where achieving optimal implant treatment outcomes requires accurate three-dimensional implant position with adequate buccal bone thickness for long-term tissue stability.<sup>2-3</sup> Nevertheless, total teeth extractions trigger a series of physiological changes affecting the alveolar bone that surrounds the extraction socket.<sup>4</sup> Loss of the periodontal ligament (PDL) and its vasculature impede nourishment of the buccal bone plate which is particularly impactful in the case of thin, mainly cortical buccal bundle bone. Consequently, loss of PDL invariably triggers loss of alveolar bone ridge dimensional stability.<sup>5,6</sup> Biomaterial-drive approaches, such as alveolar ridge preservation techniques are effective in partially countering these dimensional changes, but not eliminating them.<sup>7</sup>

In search of a true biological approach to post-extraction ridge resorption partial extraction therapies have been introduced.<sup>8-18</sup> Hürzeler and colleagues were the first to introduce the "socket shield" technique (SST), which consists of decoronating the compromised tooth and isolating the root that is dissected in the mesiodistal direction; the palatal/lingual root portion is a traumatically extracted while the buccal portion is left in situ after being reduced in thickness (to assume a concave shape) and in height (up to 1 mm above the bone crest).<sup>9-11</sup> Therefore, it is possible to insert an immediate implant palatal to the shield, and the gap between the shield and the fixture may or may not be filled with osseous graft material.<sup>9-11</sup> Subsequently, a number of techniques have emerged that deploy partial root extraction to enable implant placement while avoiding loss of PDL that results in ridge resorption.<sup>13,14,17,18</sup> The term "PDL-Mediated Implant Placement" has been coined to encompass these techniques.<sup>14</sup> Recent longitudinal studies have provided clinical evidence of the high success rates of these techniques, which include two retrospective studies with a follow-up period of five years<sup>10,13</sup> and two retrospective studies with a follow-up period of up to ten years.<sup>19,20</sup> Importantly, a recent clinical study provided

evidence that the root-membrane (RM) technique for PDL-mediated implant placement is non-inferior to no extraction based on volumetric and radiographic data<sup>21</sup>, whereas a recent systematic review of longitudinal studies concluded that strategic retention of the buccal root has a benefit in terms of dimensional ridge stability over conventional immediate implantation when implemented in carefully selected cases.<sup>22</sup> Collectively, this emerging body of evidence is on the verge of supporting PDL-mediated implant placement techniques as mainstream treatment modalities. Nonetheless, because of the recency of these techniques, little is known about the possible complications arising from their application and their management.<sup>14,24,25</sup> The aim of this case study is to present the management of a complication in the aesthetic zone utilizing the RM technique with a four-year follow-up.

## Case Description and Results

A 47-year-old male patient was referred to our clinic to restore an endodontically treated fractured right central incisor. The patient did not report any systemic disease, intake of medications, allergies, use of drugs, or cigarette use. He had a healthy periodontium, and he maintained a good level of oral hygiene. Clinical examination revealed probing depths < 4 mm in all teeth of the maxillary anterior sextant with minimal bleeding on probing (BoP). A fistula was present on tooth #11 (Fig.1a) with the radiographic examination indicating a periapical radiolucent lesion.



Fig. 1a Frontal view of the fractured tooth #11 and apical fistula.

The prognosis of the tooth was deemed hopeless and treatment plan alternatives were discussed with the patient who desired an immediate restoration post-extraction.



Fig. 1b Radiograph of tooth #11 revealing periapical lesion.

Due to the very thin buccal bone, the minimally invasive RM technique with immediate PDL-mediated implant placement was proposed to the patient in conjunction with apicoectomy and guided bone regeneration (GBR) apically to the implant. Following the patient's informed consent, the site was anesthetized locally, and the RM protocol was employed as previously described.<sup>14</sup>

All endodontic materials were removed with files through the canal following root preparation for implant placement and a semilunar incision was made 5 mm apical to the gingival margin to allow access to the periapical region.

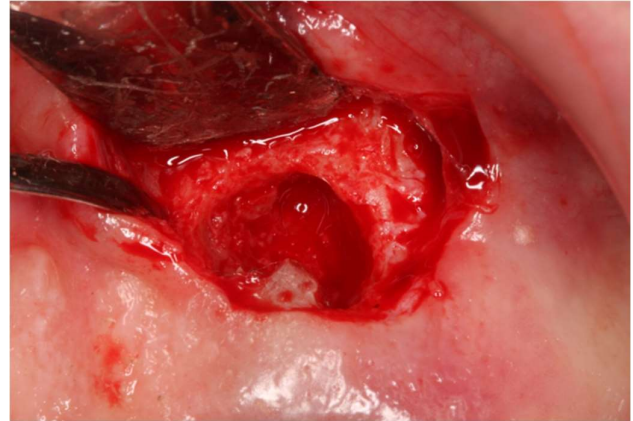


Fig. 2 Lateral window in the apical part of tooth #11.

The lesion was thoroughly debrided with a curette and irrigated with a saline solution. A self-threading tapered implant 4.5 mm X 13 mm (Anyridge®, Megagen Implant Co.) was inserted in proximity (~0.5mm horizontal gap) to the dentin of the root fragment achieving a 45 N.cm insertion torque. The apical defect was grafted with a combination of 0.5 cc of FDBA allograft (Animus, StepBiomaterials PC) and 0.5 cc bovine xenograft (Zoe, StepBiomaterials PC) at 1:1 ratio and a 20 X 30 cross-linked collagen membrane (Osseoguard, Zimmer Biomet) covered the graft materials and was fixed with titanium pins (Medipac, Kilkis, Greece).



Fig. 3 The apical part was filled with FDBA and bovine xenograft in a 1:1 ratio along with a 20x30 cross-linked collagen membrane.

The implant was immediately loaded with a screw-retained provisional restoration; its fabrication was chair-side and appropriate occlusal adjustment was made to ensure non-functional loading. A periapical radiograph was obtained to verify the final position.

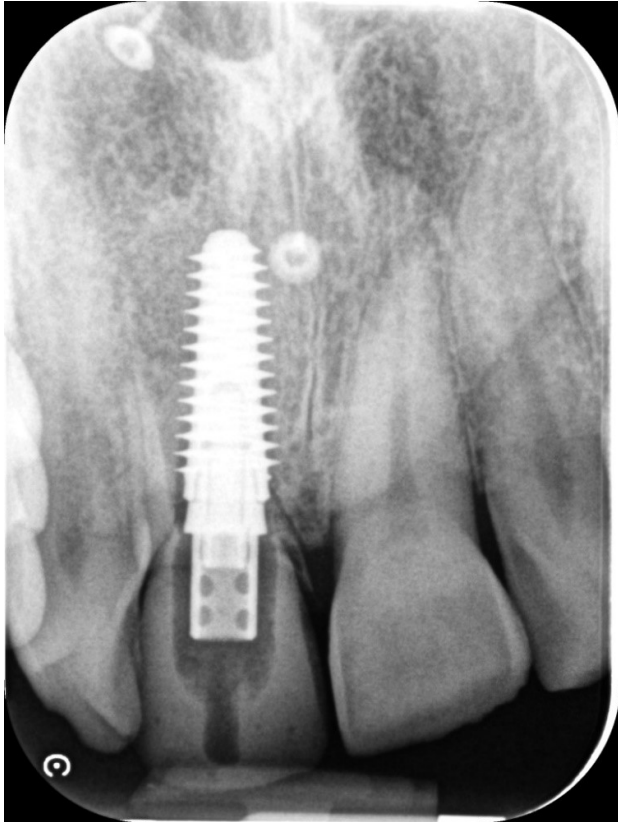


Fig. 4 Radiograph taken after implant placement.

The patient was prescribed antibiotics (1 gr amoxicillin with clavulanic acid) for a week and was instructed to rinse with a 0.2% solution of chlorhexidine twice a day until suture removal after two weeks. Subsequently, oral hygiene was resumed with a soft toothbrush and prophylaxis was performed every two weeks for the first two months and then once a month until final restoration, which was delivered by the prosthodontist at eight months post-surgery.



Fig. 5 Frontal view of the final implant restoration.

After one year in function, the patient presented complaining of pain and swelling. Clinical examination revealed a deep probing depth of 7 mm on the buccal of #11 with a fistula at the

apical area. It was decided to perform surgery to remove the root fragment and to regenerate the area. The prosthetic restoration was removed, and a healing abutment was placed.

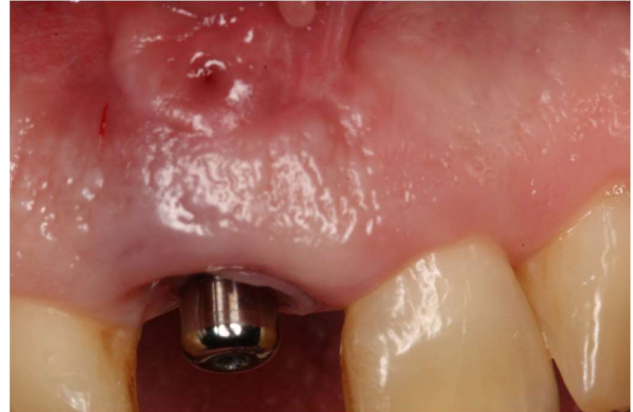


Fig. 6 One year later, the patient presented with an apical fistula with deep probing depth. The implant restoration was removed, and a healing abutment was placed to perform the surgery.

Two vertical incisions were performed mesial and distal to tooth #11 and after flap elevation the fractured root was revealed.

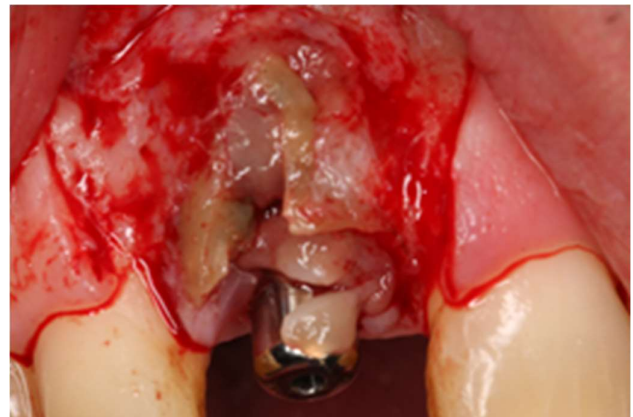


Fig. 7 After flap elevation, the fracture of the root membrane can be noticed.

The root was removed along with granulation tissue and the implant surface was decontaminated with Er:YAG laser (Light Instruments) in 40 mJ and 20 Hz.



Fig. 8a The root fragment was removed, as well as the granular tissue and the implant surface was decontaminated with Er:YAG laser in 40 mJ and 20 Hz.



Fig. 8b Debridement and decontamination of the surgical buccal area revealed six exposed implant threads.

A mixture of 0.5 cc of Freeze-Dried Bone Allograft (FDBA) and 0.5 cc bovine xenograft in a 1:1 ratio was placed in combination with a titanium membrane (i-Gen B2, Megagen Implant Co.) which was stabilized with a titanium screw (Pro-fix™, Osteogenics) apically. The cervical area of the prosthetic restoration provided further stability to the titanium membrane after adaptation in the coronal region.

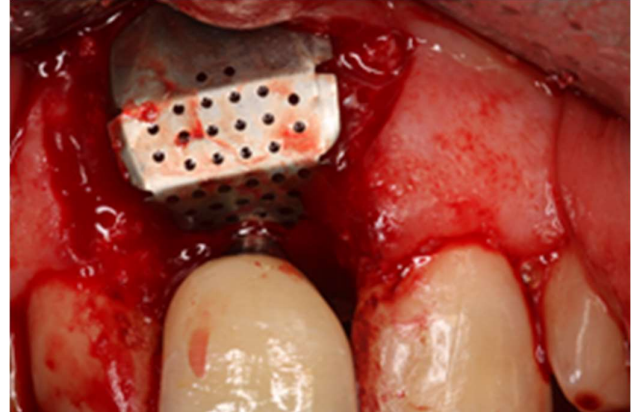


Fig. 9 A mixture of FDBA and bovine xenograft in a 1:1 ratio was placed in combination with a titanium membrane which was stabilized with a titanium screw apically and the prosthetic restoration through its neck.

The flap was repositioned and sutured with 4-0 polytetrafluoroethylene (PTFE) suture (Medipac, Kilkis, Greece). The post-op routine was similar to that of the first surgery. After six months, the titanium membrane was removed, and the tissues were left to heal. Four years after the final surgery, a cone beam computed tomography (CBCT) was taken to assess the width of the regenerated buccal bone plate; both clinical and radiographic examinations show stability in soft tissues and bone level.

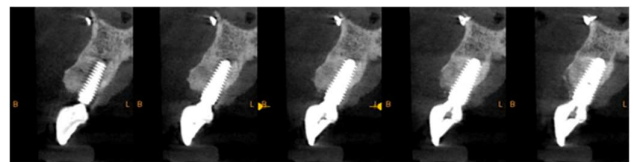


Fig.10a CBCT taken four years after surgical intervention.



Fig. 10b Four-years frontal view of tooth #11.

Consistent with the elimination of the root and its PDL, a small shrinkage of tissue was noted that led to a minor papillary recession of the midline papilla.

## Discussion

To the best of our knowledge, this is the first published report of a PDL-mediated immediate implant placement related complication with four-year follow-up. In our case, we present an approach for total root extraction to mitigate the complications related to the periapical pathology of the tooth. The rate of complications associated with dental pathology in PDL-mediated implant placement cases is not well documented. Even though limited longitudinal data is available concerning the success rates of this technique, the studies show that it is a reliable method for immediate implant placement in the aesthetic zone with very few complications.<sup>10,13,20</sup>

The first study that evaluated potential complications was published by Davarpanah and Szmukler-Moncler in 2009 who reported a case series of five patients.<sup>24</sup> Their intention was not PDL-mediated immediate implant placement, but they placed implants in contact with root fragments to avoid their traumatic extraction. They reported a limited resorption of dentin at one site after four years of loading, which was attributed to local implant overload.

Siormpas et al in a retrospective analysis of forty-six patients reported one complication at thirty-six months post-loading.<sup>13</sup> There was an apical root resorption of the retained root fragment of about 1.5 mm that was monitored. A CBCT obtained six years after implant placement verified resorptive substitution at the root apex and fill of the defect by radiopaque tissue that verified a pending clinical diagnosis of replacement resorption. This finding did not compromise the survival of the implant.

A systematic review of four histologic studies and nineteen clinical studies regarding SST efficacy reported several types of complications.<sup>23</sup> Histologically, the most common complication was crestal bone loss along with failure to osseointegrate. As a gold standard reference on the successful histological findings of PDL-mediated implant placement, both pre-clinical data<sup>13</sup> and data from an implant placed in the human anterior maxilla, using the RM technique,

show that the buccal bone plate maintained without any resorption for at least five years in functional contact with a healthy PDL.<sup>25</sup> Clinically, the most frequent complications included exposure of the shield and deep probing depths. While robust data to determine the optimal approaches to mitigate these complications is not available, it has been speculated that the vertical position of the retained root and the management of the horizontal gap are critical areas. In the RM technique that was employed in this case the horizontal gap is less than 1.5mm and no effort is made to graft this space; in addition, this technique relies on harnessing the cellular and transcriptional milieu of the PDL and the associated vascular contribution to achieve tissue bridging between the retained root and dental implant.<sup>13,14</sup> In support of this approach, a human histology case study showed osseointegration, with a high percentage of bone-to-implant contact (BIC = 76.2%).<sup>25</sup> With regard to the space between the RM and the implant, the apical and medial thirds were filled with mature bone, and the coronal third was colonized by non-infiltrated connective tissue.

Among published clinical studies, the majority of complications needed no additional treatment other than frequent follow-ups. In a recently published case study, a complication with its surgical management was presented where a socket shield was mobile, and it was decided to remove it. The resulting defect was filled with a bovine xenograft and a connective tissue graft.<sup>26</sup> One year after the surgery a satisfactory result was achieved.

In regard to the case presented, the reasons for the complication can only be speculated. The patient in question is an avid scuba diver and pressure as well as the negative pressure that is created in the oral cavity might have affected the outcome that led to this early complication. His habit in combination with the fact that the remaining root fragment was relatively short, even though immobile, might have contributed to the mobilization of the root which led to the creation of the inflammation and the catastrophic lesion. Nevertheless, the present case demonstrated that this kind of complication is surgically manageable, and the results of the rescue treatment are stable over time.

## Conclusion

Longitudinal studies have shown that retention of the buccal root has a benefit in terms of dimensional ridge alterations over conventional immediate implantation when implemented in carefully selected cases of high aesthetic expectations. Nonetheless, because of the recency of these techniques, little is known about the possible complications arising from their application so further clinical studies are needed concerning their management.

## Conflict of interest statement

Dr. Siompas is one of the developers of the RM kit and has received honoraria from Megagen. The remaining authors declare no conflict of interest.

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