Immediate implant placement in the esthetic zone utilizing the “root-membrane” technique: a case report with 3 years follow-up

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Abstract: Numerous studies have documented that tooth extraction causes changes in buccolingual and vertical dimensions of the alveolar morphology. Even though several techniques have been applied to manage this unavoidable sequel of bone resorption, none of them can completely achieve maintenance of initial morphology. An innovative modality for dimensional stability of the residual socket is the “root-membrane technique” (RMT). This involves retention of the labial portion of the root together with its periodontal attachment (PA) followed by immediate implant placement. The aim of this article is to report a case of a 37-year-old male who had been diagnosed with a vertical fracture at a central maxillary incisor and was successfully treated using the RMT. The successful outcome of this technique indicated that the retention of the root fragment in the buccal aspect of an inserted implant may critically contribute to the preservation of normal alveolar architecture in the aesthetic zone. However, randomized control studies with a large number of patients are required to fully document the long term outcomes of this technique.

Key words: root, dentine fragment, immediate implant placement, aesthetic zone, dental implant, membrane, dentine, cementum

One of the principal goals for dental implant restorations is the maintenance of normal local architecture of both hard and soft tissues in the recipient site. Especially for the anterior region of maxillary arch, the optimal aesthetic outcome should combine the accurate three-dimensional implant position with adequate buccal bone thickness. Nevertheless, clinicians have to take into account, that every tooth extraction triggers significant dimensional alterations of local tissues. These unfavorable consequences may be properly managed by various techniques, but none of them can predictably preserve the initial normal morphology.

Alternatively, the “root-membrane technique” (RMT) has been evolved in order to prevent any morphological alteration and to provide the most possible natural appearance. The aforementioned approach entails that a part of the root should remain on the buccal/labial aspect of the residual socket preserving the connection with its periodontal ligament. Thereby, the blood supply of the labial plate remains intact and the bone resorption is very likely to be negligible. Moreover, the potential need for bone graft materials may be eliminated.

The aim of this article was to describe all the stages of the implant rehabilitation in a 37-year-old patient who had been diagnosed with a vertical fracture in central maxillary incisor and successfully treated with RMT protocol.

Case report

A 37-year-old male patient referred to our clinic from another dentist in order to treat a fractured right central incisor secondary to a blow on his face. As a temporary measure, immobilization with composite resin had been preformed. The patient was free of systematic diseases and his medical history did not include intake of medications, allergies, alcohol, drugs, or cigarette use. His dental history did not reveal any active or severe periodontal disease and the patient maintained a good level of oral hygiene. On clinical examination, the tactile palpation induced pain and mobility of third degree. The radiographic control encompassed panoramic radiograph and cone-beam computed tomography (CBCT) which both indicated signs of a vertical linear fracture for the affected tooth (Fig. 1).

Also, a radiolucent lesion was found palatally to the root, while the endodontic treatment was considered incomplete. The bone support for the adjacent teeth was normal and there was no evidence of fracture for the labial plate in the injured site.
Since the fracture was subcrestal and the affected tooth had a long metal post without possibility for restoration, the extraction was unavoidable. The available treatment plans after the extraction were discussed with the patient, who sought an immediate restoration. Due to this type of injury with the associated risk of labial plate resorption, the minimally invasive option of RMT was proposed to the patient and was accepted as the ideal treatment plan.

After disinfection of oral cavity with 0.20% chlorhexidine solution for 30 seconds, local anesthesia was performed using lidocaine hydrochloride (2%) and adrenaline (1:80,000). Then, the coronal fractured part of tooth was gently removed by forceps. The post was totally removed with special ultrasonic instruments. Afterwards, a small amount of dental tissue was removed with a bur up to the level of crestal bone. The next step involved sequential drillings for immediate implant placement with special caution to engage the lingual half of the root and the palatal aspect of the socket during preparation of the bed (Fig. 2). By this manner, the labial segment of retained root was kept in place without traumatizing the buccal bone during the drilling.

After this, a mesio-distal cut of remaining root is performed with a carbide bur (5909-040, Brasseler) in order to bisect it into a labial and a palatal portion. The latter was eventually removed from the socket with mild manipulations, commonly with the use of a root tip forceps or a perirotome (Fig. 3). The procedure was continued with the reduction and bevelling of the buccal root fragment approximately below 1-2 mm of the crestal bone margin. A 4 mm in width and 11.5 length tapered and self-threading implant (Anyridge®, Megagen Implant Co., Ltd., Gangnam-gu, Korea) was inserted in proximity with the dentin of the root fragment, by using a handpiece set at 20 rpm and 40 N/cm² torque (Fig. 4). Thus, the implant was fixed closely to bone walls, except from its buccal aspect where dentin, cementum, periodontal ligament, and bundle bone were intervened between the labial bone and the implant threads in an orofacial direction. The implant was immediately loaded with a screw-retained provisional restoration; its fabrication was chair-side performed while thorough occlusal adjacement was made to ensure no functional occlusion (Fig. 5). The exact position of the inserted implant as well as its relation with the retained root fragment was confirmed by a CBCT (Fig. 6).

Antibiotics (amoxicillin 500 mg tid) and analgesics (ibuprofen 600 mg tid) were prescribed for the first post-operative 5-days. Also, the patient was instructed to avoid any potential source of trauma, such as brushing and intake of hard food, for 10 days. For disinfection of the post-operative site, the use of an oral solution of chlorhexidine 0.12% was recommended twice a day for the following 2 weeks. Patient came for a 2 week post-up and after clinical and radiographic examination was found to be within physiological healing process. He was recommended to come after 6 weeks for the final rehabilitation.

After 6 weeks patient came for the final prosthesis. Upon removal of his provisional prosthesis a final impression was taken with a standard impression coping.
Implants

Case report

(Anyridge®, Megagen Implant Co., Ltd., Gangnam-gu, Korea) using the close tray impression technique. After 2 weeks the final cemented restoration was delivered (Fig. 7-8). Cementation occurred using a provisional cement (Temp-Bond™, Kerr Dental).

The patient was instructed to visit our clinic every 6 months for a regular periodontal evaluation. 3 years after patient was evaluated again and was found without any changes both aesthetically and radiographically as well (Fig 9-11).

Discussion

Every tooth extraction is expected to lead to a remodeling process affecting the bone volume of the residual alveolar ridge. Several studies have found that there is a greater amount of decrease in horizontal dimension than in a vertical one. Indeed, the percentage of vertical decrease is estimated 11-22% at 6 months, while for the horizontal dimensional alterations the percentage varies between 29 and 63% within the same period.

Furthermore, the process of resorption and remodeling, which occurs in residual socket from the early healing stages, will relocate the crestal margins to a more apical level and to a more lingual-palatal position. Araujo and Lindhe deemed that larger quantity of bundle bone is found in buccal plate in comparison to lingual plate. Since the buccal plate is considered as a tooth-dependent structure, tooth extraction reasonably contributes to looming, rapid, and substantial resorption of it.

Fig. 2: Occlusal view of dentinotomy/osteotomy after sequential drilling.
Fig. 3: Occlusal view after removal of palatal part of the root.
Fig. 4: Implant placement 1mm below crest.
Fig. 5: Immediate chair side provisional restoration.
In terms of implant restorations in the aesthetic zone, the integrity of buccal/labial plate is of paramount importance as it supports the mucosal margin and thereby configures the architecture of the alveolar process.\(^2\)\(^{-}\)\(^{12}\) Taking into account that buccal/labial bone thickness at crestal level is 0.5-1 mm for 73% of incisors\(^1\)\(^{3}\) and 78.8% of central incisors are located more buccally within the alveolar socket\(^2\), there is an increased risk for healing complications and bone dehiscence after an implant placement in these sites.\(^4\)

Provided that an implant surface is not covered by bone, the following aesthetic complications may arise\(^5\):
1. Soft tissue recession and exposure of implant threads.
2. Blue-grey shade on soft tissues covering the bone dehiscence, in case of thin peri-implant tissues.
3. Absence of normal radicular eminence and flattened appearance for the buccal/labial aspect of the alveolar ridge.

To overcome the aforementioned complications, ridge preservation techniques and reconstruction procedures have been evolved both to minimize the socket walls resorption and to achieve new bone formation within the socket.\(^6\) These techniques consist of immediate or early implant placement, implant positioning on the palatal wall in conjunction with guided bone regeneration, utilization of soft-tissue or bone grafts, ridge splitting or expansion, osteotomies of the jawbone, distraction osteogenesis as well as combination of the above.\(^7\)\(^{-}\)\(^{10}\) Despite their effectiveness, all of these techniques not only cannot completely prevent the resorption process but also increase the complexity, the time length, and cost of the whole treatment plan. Thus, patients may reasonably tend to solicit an alternative and less complex treatment plan.\(^2\)\(^{0}\)

The RMT constitutes another minimally-invasive option for both simple and satisfactory aesthetic outcomes in implant restorations, as its main goal is to preserve the normal architecture of hard and soft tissues of the alveolar process.\(^4\) Indeed, the maintenance of the buccal/labial root fragment of the extracted root seems to be beneficial for ridge preservation mainly when combined with immediate implant placement.\(^2\)\(^{0}\) The retention of this fragment serves to protect the periodontal ligament and the supracrestal attachment fibers on the buccal/labial tooth aspect, thereby omitting the potential of bone remodeling.\(^4\)\(^,\)\(^{18}\)\(^,\)\(^{21}\)

The appropriate selection of the candidate case for RMT is critical for the successful outcome; the RMT indications can be defined and fall into:\(^2\)\(^{0}\)
1. Patients with good general health status and high level of oral hygiene.

ii. Patient with high smile line.
iii. Teeth diagnosed with horizontal and vertical fractured extended over the bone level.
iv. Teeth in esthetic zone which cannot be treated as a result of large carious lesions.
v. Teeth with poor prognosis and without acute inflammation.
vi. Absence of periodontal disease.

It should be stressed that periodontal ligament is responsible for a significant portion of blood supply of the buccal/labial bone. Moreover, the integrity of dentogingival fiber insertion preserves the amount of keratinized width.\(^2\)\(^{3}\) By achieving adequate soft tissue thickness (sufficient quantity and quality of keratinized tissue), there is low risk of bone recession and exposure of metal components.\(^2\)\(^{4}\) Besides, the optimal prosthetically driven positioning in case of immediate implant placement may be established under the guidance of the retained root fragment.\(^2\)\(^{5}\) Specifically, the long axis of the root fragment can determine the mesio-distal positions of the drills as well as its volume enables implant placement on the palatal 2/3rds of the socket.\(^2\)\(^{0}\) Therefore, by this manner, critical aesthetic issues such as the emergence profile of implant supported restorations, bucco-lingual relationships, and embrasure shape may be properly addressed.\(^2\)\(^{4}\) Noteworthy, the RMT comprises a flapless approach which in turn does not violate the blood supply of buccal/labial bone and does not cause surgical trauma effects on hard and soft tissue of the site.\(^2\)\(^{3}\)\(^,\)\(^{25}\)\(^,\)\(^{26}\)

For those implants that had been placed in direct proximity with fragments of dental tissues, there are animal studies indicating that bone-to-implant surface
exhibited the typical view of osseointegration without inflammatory or resorptional processes.\textsuperscript{18,22} In addition, the specific part of implant surface being close to non-bony mineralized tissues developed mineral integration as well as formation of new cementum and new collagen fibers of periodontal ligament.\textsuperscript{4,21,28} In addition, the dentin of root fragment is covered by a newly formed acellular cementum which progressively exhibited its cementoblasts and production of cementoid; collagen fiber bundles are anchored in it.\textsuperscript{21} Bäumer et al.\textsuperscript{22} used beagle dogs to conduct histological evaluation of sockets had undergone implant placement with root fragment retention on their buccal sides. The authors showed that normal periodontal ligament was buccally developed, with greater bone height for the buccal plate compared to the lingual one. Recently the first
human histological study was published by Mitsias et al. Indication with precision the presence of well matured bone between the implant thread and the root surface.29

With regard to human studies, Bäumer et al.23 retrospectively evaluated 10 consecutive patients (mean follow-up = 58 months) where implant placement in anterior maxilla region was made with RMT protocol. To perform volumetric analysis of changes in the alveolar processes, the study design involved 3D-surface scans of casts fabricated before extraction and 5 years after implant placement, and Afterwards comparison with digital superimposition. The results of this study demonstrated minimal contour alterations, whereas the mucosal recession between implant restoration and its adjacent teeth was not statistically significant. The clinical measurements yielded high aesthetic outcomes with minimal marginal bone loss at the implant shoulder, and at the medial and distal aspects. The mean pink aesthetic score was estimated 12.

The RMT requires high-level operator’s skills and ability for management of any possible complications having negative impact on aesthetic outcome. Indeed, adverse consequences may occur such as resorption of root fragment due to inflammatory process or ankylosis, fragment extrusion, development of carious lesion, pocket formation,4,19 and root and/or implant exposure.22

Conclusions

The RMT can provide optimal aesthetics, for selected cases, when implant restorations are planned for the anterior part of maxillary arch. It is also beneficial for those patients seeking less complex and minimal invasive treatment. However, randomized controlled studies with histological documentation are essential to completely assess its long-term outcomes and to allow its incorporation in routine clinical practice.

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