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Treatment of Pathologically Migrated Teeth: Modified Intentional Replantation

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Abstract— *This study aims to address factors that need to be considered when performing modified intentional replantation (MIR) for teeth with hopeless prognoses and to improve the current MIR surgical technique to enhance the treatment outcomes. One in three patients experiences pathologic tooth migration (PTM) caused by periodontal disease. PTM demonstrates a unique pattern for each periodontal condition. MIR is a treatment option for PTM caused by severe periodontitis. It requires using implant drills to prepare the alveolus for replantation. This technique could improve clinical periodontal indicators, such as probing pocket depth, bleeding on probing, and tooth mobility.*

Keywords— *Intentional replantation, Implant drill, Pathologic tooth migration, Treatment of pathologically migrated teeth(PTM), Modified intentional replantation(MIR).*

I. INTRODUCTION

Our dentition undergoes constant mastication throughout life. When oral hygiene is persistently neglected, the periodontal apparatus around teeth starts to weaken, which may cause the teeth to slowly migrate without directionality. This is defined as pathologic tooth migration (PTM)[1]. One in three patients experience PTM during their lifetime. Initially, PTM poses aesthetic concerns for patients but later leads to compromised functionality. Martines et al[2] in 1997 defined PTM as the migration of teeth due to the destruction of periodontal apparatus around teeth. The most frequent types of PTM include facial flaring (34.80%), diastema (27.00%), proximal tilting (20.00%), tooth rotation (34.80%), and extrusion (4.30%).

McGuire et al[3]. in 1996 classified the prognosis of teeth following periodontal treatment as excellent, good, fair, poor, questionable, and hopeless.

Depending on the severity of the periodontal disease, the speed at which teeth migrate may accelerate. The extent of the migration depends on the scope of the periodontal destruction. Suppose teeth have migrated less than 3mm and have a good prognosis. In that case, simple periodontal treatment may stop the progression, and the teeth may be orthodontically moved back to their original position[4]. Except for teeth with a hopeless prognosis, PTM could be controlled with non-surgical periodontal therapy followed by surgical or orthodontic therapy[5].

Why Intentional Replantation is Necessary.

With the recent advancement in implantology, the treatment options for teeth with hopeless prognoses have expanded. Extraction of teeth followed by implant placement has become the preferred option for many patients. For patients who refuse extractions and show a strong desire to maintain teeth, intentional replantation (IR) may be considered. IR entails surgically removing the tooth, endodontically treating it extraoral, and replanting it in its alveolus[6].

There have been multiple case studies in the U.S. and Japan demonstrating the success of IR[6~9]. This procedure is only indicated when the periodontium sufficiently remains and when the patient is not in pain due to periodontal disease.

Patients who recognize their own PTM seek dental care to address their esthetic concerns even if they do not experience dental pain. When PTM becomes chronic, and extrusion occurs, bone apposition is observed at the apical portion of the tooth, modifying the volume of the original tooth alveolus. To replant a tooth to its own alveolus in its original position, implant drills are used to perform an osteotomy to create adequate space for replantation. This method is called modified intentional replantation (MIR)[8,9].

Modified Intentional Replantation, An Alternative to Dental Implants

Many patients with severe PTM seek dental care with only dental implants in mind. There is a need to educate and spread awareness to patients and dental providers regarding alternative treatment options, such as MIR[10]. MIR should be considered when discussing all potential treatment alternatives with patients, especially for those who have strong desires to maintain their natural teeth or are opposed to using foreign materials[11].

Dental implants are exposed to the same bacterial microbes as natural teeth intraorally. The alveolar bone surrounding dental implants becomes compromised when the peri-implant condition is transitioned from mucositis to implantitis[12].

While a natural tooth is surrounded by a periodontal ligament, which is in contact with the alveolar bone, a dental implant develops a direct interface with the bone. The periodontal ligament allows natural teeth to maintain homeostasis with the surrounding bone. The lack of periodontal ligament in implants causes decreased vascularity and weaker gingiva connective tissue fiber insertions in the suprarenal gingiva, increasing the risk of faster progression of bacterial invasion[13].

Histological findings have demonstrated that the extent of bacterial infection was found to be greater around implants than around natural teeth[13]. In addition, various bacterial microbes have been found around implants.

Modified Intentional Replantation, Criteria for Success

If the periodontal ligament remains intact or is regenerated

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following MIR, the success of the replantation may be comparable to dental implants. It may provide a viable option for a select group of patients who are opposed to dental implants or want to maintain their hopeless teeth[14]. However, multiple case studies have been reported showing rapid destruction of the periodontal ligament following replantation[15].

Complications of replantation include pulpal necrosis, inflammatory root resorption, replacement root resorption, and ankylosis[15]. Replacement resorption occurs due to damaged periodontal ligament and is irreversible, whereas inflammatory resorption may be managed with root canal treatment[16].

Depending on the extent of periodontal disease, PTM may progress rapidly as both the periodontal apparatus and the surrounding alveolar bone may be damaged or resorbed[17]. Severely migrated or extruded teeth may require osteotomy to achieve enough space for replantation in the original alveolus, in which case MIR would be indicated[17].

Periodontal ligament is a complex multifunctional connective tissue unit containing sharpey's fibers, vessels, and nerves. When a tooth is extracted, the most damage is incurred to the periodontal ligament as all three components mentioned above are lacerated[18].

The alveolus and cementum's surface layer may also be mechanically removed during the process. Periodontal ligament contains undifferentiated stem cells that could differentiate into cementoblasts, fibroblasts, and osteoblasts, allowing for rapid reconstruction of the periodontium following trauma[19]. Therefore, the key determining factor for the success of replantation is the activation of the periodontal ligament stem cells[19].

Atraumatic extractions must be performed to minimize trauma to the periodontal ligament. All inflamed tissues must be removed from the tooth before replantation, as only a healthy periodontal ligament can induce the regeneration of the periodontal apparatus[20].

The preservation of the periodontal ligament is crucial in preventing root resorption. Inflammation following traumatic extraction may trigger osteoclastic activity, leading to cementum resorption[16]. As part of the homeostatic mechanism, osteoblasts are, in return, activated to form bone, leading to the outcome of replacement resorption[16].

Without the protection of the periodontal ligament, the root of the replanted tooth may undergo invasion by osteoclasts. In addition, the vasculature in the periodontal ligament supplies nutrition and immune cells to the periodontal apparatus and, thus, directly contributes to the longevity of the tooth survival[11].

Internal root resorption occurs classically following localized coronal pulp necrosis. In many cases, it occurs secondary to trauma, and this damage, combined with the localized necrotic pulp tissue, stimulates an inflammatory reaction in the adjacent pulp tissue, leading to the progression of root resorption until complete pulp necrosis is achieved[15].

External resorption is triggered by the loss or damaged precementum lining the root surface and the inflammation of the adjacent periodontal ligament, which activates odontoblasts[16]. Lateral external inflammatory root resorption tends to occur following trauma, such as severe luxation or avulsion, and is associated with both pulp necrosis and damaged root surface[17].

If lateral external inflammatory root resorption becomes progressive, replacement resorption or ankylosis may follow. When managed early, external and internal root resorption can be resolved with non-surgical root canal therapy. In contrast, no standard intervention exists in the case of replacement resorption[17]. There is one exception where if infraocclusion occurs by 1mm following ankylosis, it is advised to perform pre-empt coronal fracture and treat the site with implant placement[15].

Compared to IR, MIR necessitates the usage of implant drills to achieve adequate amount of space for the tooth to be replanted as well as the periodontal ligament. The osteotomy must be performed accurately and conservatively using radiographic and clinical examination. Intramarrow penetration has previously been shown to improve periodontal regeneration[21], and likewise, this osteotomy as part of MIR is expected to contribute to the stimulation of the periodontal apparatus regeneration[22].

Growth factors, many of which are found in platelet-rich fibrin derived from patients' blood, can stimulate periodontal ligament stem cells and allow for the regeneration of the periodontal apparatus[20].

As it is crucial to activating periodontal ligament stem cells as part of MIR, the usage of growth factors has been tested in clinical settings. Platelets contain α-granules, which house growth factors such as platelet-derived growth factor (PDGF), insulin-like growth factor (IGF), transforming growth factor-β (TGF-β), endothelial growth factor (EGF), and vascular endothelial growth factor (VEGF)[19]. Further investigation is needed to uncover the growth factors' total impact on the periodontal apparatus's regeneration.

Precautionary Measures for Replantation

During MIR, the extraoral time must be minimized to maximize the periodontal apparatus's regeneration and ensure a favorable prognosis of the replanted tooth. To avoid chronic inflammation and pulp necrosis, the tooth must also undergo sufficient curettage to remove all infected tissue. If infected tissues remain on the root before replantation, the chance of reinfection increases, as well as triggering the release of inflammatory cytokines, such as IL-1 and TNF-a[11].

The prognosis of the replanted tooth depends on the pulp. The pulp contains microvasculature and lymphatic vessels that connect to the periodontal apparatus and, therefore, affect the health of the periodontal ligament. Replanted teeth with poor prognoses tend to be involved with root resorption due to the destruction of the periodontal ligament[9].

On the other hand, inflammatory root resorption is known to be partly triggered by pulp necrosis. Therefore, to assess the success of replantation, one must evaluate whether the health of the regenerated periodontal apparatus is comparable to that of a natural tooth and provide root canal treatment to avoid and manage root resorption.

Complications of Replantation and The Importance of Curettage

Following extraction, the bone around the alveolus is known

to undergo bone resorption, 40% in height and 60% in width within the first 6 months[12]. If bone resorption continues, it imposes issues for prosthodontic treatments. MIR serves to prevent further bone resorption[6]. Ankylosis and root resorption are the most common complications following replantation[13,14]. They both occur and progress over a long period. The extraction must follow if root resorption becomes extensive enough to cause tooth mobility.

Root resorption is followed by the apposition of alveolar bone, and as a result, the total amount of bone is maintained[6]. This is helpful for prosthetic and implant treatments. The periodontal ligament prevents complications, such as root resorption and ankylosis. The periodontal ligament connects the alveolar bone and cementum. Functioning periodontal ligament serves to prevent the abovementioned complications[16].

Therefore, if the periodontal ligament remains intact, the success of replantation increases. Complete removal of infected tissues around the extracted tooth through curettage increases the viability of the remaining periodontal ligament cells. In 2012, Noda et al[19]. showed that replantation after completely removing the periodontal ligament and cementum, followed by the application of PDGF-BB, stimulated the regeneration of the periodontal apparatus in the coronal direction. This finding suggests great promise for using growth factors in MIR and the importance of maintaining the remaining periodontal ligament cells.

In 2011, Park et al[20]. reported that the periodontal ligament contains stem cells that can differentiate into cementoblasts, periodontal ligament cells, and osteoblasts. Following extraction, dentists must perform curettage conservatively with light forces to preserve the remaining periodontal apparatus and rinse thoroughly with normal saline. The extent of curettage to remove the infected tissues around a tooth remains controversial. If inflammation occurs, the tooth must be root planed or treated with antibiotics to resolve the infection before replantation.

II. Conclusion

Extractions are indicated if a hopeless tooth does not respond to periodontal therapy, followed by prosthodontic treatment. However, if the patient insists on maintaining the tooth, MIR may be an alternative solution. If there is an adequate amount of space in the alveolus for both the tooth and the periodontal ligament, IR may be performed. However, if the room is lacking due to PTM, MIR may be performed with conservative osteotomy. In severely migrated teeth, MIR may still be difficult to guarantee a successful outcome. However, using growth factors may enhance the regeneration of the periodontal apparatus and increase the success of MIR.

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