Case Report

Forced eruption in esthetic zone from the prosthetic point of view: A case report

Jeng-Feng Hwang, DDS, DMD, MPH[a], I-Chiang Chou, DDS, PhD[b], Yu-Lin Lai, DDS, MS[c], Shyh-Yuan Lee, DDS, DScD[d]

[a]Private practice, Taipei, Taiwan

[b]Chair, Department of Stomatology, Taipei City Hospital Yang-Ming Branch, Taipei, Taiwan; Assistant Professor, Department of Dentistry, National Yang Ming Chiao Tung University, Taipei, Taiwan

[c]Director, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan; Professor, Department of Dentistry, National Yang Ming Chiao Tung University, Taipei, Taiwan

[d]Professor, Department of Dentistry, National Yang Ming Chiao Tung University, Taipei, Taiwan; Attending doctor, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan; Researcher, Department of Dentistry, Taipei City Hospital, Taipei, Taiwan

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Corresponding author:
Shyh-Yuan Lee
Department of Dentistry
National Yang Ming Chiao Tung University
No 155, Sec 2, Li-Nong Street
Beitou District
Taipei
Taiwan
E-mail: sylee@ym.edu.tw

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Abstract

Orthodontic extrusion is a common technique to manage a complicated crown-root fracture for re-establishing biologic width of the tooth and elevation of the fractured margin to provide proper ferrule for the crown restoration. However, ill-controlled orthodontic extrusion force on the tapered narrow roots sometimes could induce facial tipping force, and thus cause iatrogenic gingival recession and root dehiscence. This case report describes a simple manner to avoid facial tipping force by using a provisional crown with an additive contour at the facial gingival level to reduce the risk of this complication. The lingualized vector force not only preserves the precarious labial bone plate of the traumatized root but also creates a restorative space which shall minimize the needs of tooth reduction for the crown restoration.

Key words: orthodontic extrusion; forced eruption; fiberotomy; complicated crown-root fracture; biologic width; ferrule effect

Introduction

The complicated crown-root fracture is common in accident. Literatures have shown several modalities to solve the problems that may be encountered. In which, how to manage the traumatized tooth in esthetic zone is really a challenge. The prognosis of the traumatized tooth is majorly based on the position of the fractured line and the future role of the tooth in function and esthetics. In general, re-establishing biologic width and creating sound restorative ferrule of the teeth are mandatory to restore the fractured roots. Clinically, there are three ways to relocate the fracture line, including orthodontic extrusion, crown lengthening procedure, and surgical extrusion[1-3].

As concerns of soft tissue and hard tissue profile in esthetic zone, orthodontic extrusion is the most common way to apply on the fractured anterior teeth. Orthodontic extrusion, also known as forced eruption, was first introduced to change the bony topography around teeth. It was found that periodontal angular bony defects could be improved and even eliminated by orthodontic movement of the tooth [4,5]. Further, soft and hard tissue augmentation was introduced to prepare the recipient dental implant site using orthodontic extrusion of the hopeless

roots [6-8]. However, orthodontic forced eruption with the straight-wire appliance in implant site development resulted in favorable increase in the heights of the palatal and proximal alveolar bone but significant reduction in the buccal plate height, which inhibited implant placement in 35% of the treated sockets[9].

The mechanical eruption of the tooth involves applying a direct force to the tooth in a specific direction, which creates a tension on the periodontal ligament fibers and leads to new bone formation at the crestal aspect of the alveolar bone. Obviously, the direction of the orthodontic force should be carefully controlled, otherwise iatrogenic complications of gingival recession or even root dehiscence could occur if the orthodontic force tipped facially, which will compress the fragile buccal plate and end up with [7,9-12] instead of bone deposition. This case report aims to provide a simple modality to guide the orthodontic force lingually to ensure labial bone plate preservation by using a modified provisional crown with an over-contour at facial cervical zone. The results of a 14-year follow up are presented.

Case report

A 29-year-old male patient presented with fractured upper central incisors (#11 and #21 in the FDI numbering system) and a scar on the upper lip (Fig. 1A). The patient reported that the teeth were injured 1 week before this visit. His medical history was noncontributory. Intraoral examination revealed that the maxillary right central incisor had an oblique root fracture and the fracture line extended subgingivally at the palatal surface of the tooth (Fig. 1B); and the maxillary left central incisor was suffered from fracture at middle third with fresh scarring tissue surrounding. The fractured line over left lateral incisor (#22) was noted and showed no sign of mobility and positive response to an electric pulp test. A periapical radiograph (Fig. 1D) demonstrated fair bone support of the teeth without obvious crack lines along the roots or alveolar fracture, and the trauma was limited to clinical crown fracture of incisors. The biologic width had been directly violated by the fracture at #11 palatal site (Fig. 1C) and there was inadequate tooth structure to achieve a ferrule effect for the subsequent crown restoration. Both the right and left central incisors received emergency endodontic instrumentation and the pulp chambers were filled with calcium hydroxide and covered by IRM.

For the treatment plan for #21 was easy to reach a consensus, while the treatment of # 11 was more complicated. A number of treatment options were offered. If the patient was willing to keep #11, orthodontic extrusion of the tooth with or without crown lengthening was suggested; otherwise extracting tooth #11 and placing an implant or having a fixed bridge was recommended. Considering the financial and social reasons, the patient opted for the treatment of orthodontic extrusion of # 11 without crown lengthening, and then reconstruction of both #11 and #21 with a fiber post and resin core and a full ceramic crown.

After the patient was treated with dental prophylaxis, both incisors were instrumented under a modified rubber dam isolation, and the endodontic treatment was completed with the

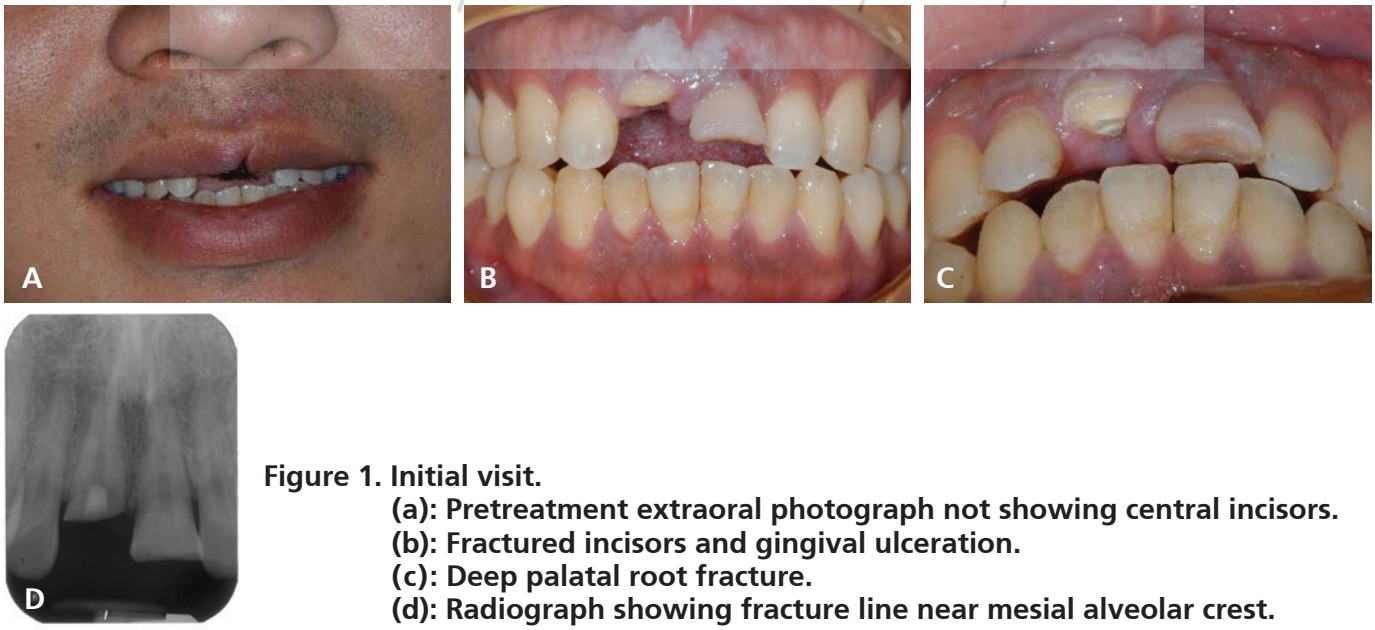

Figure 1. Initial visit.
(a): Pretreatment extraoral photograph not showing central incisors.
(b): Fractured incisors and gingival ulceration.
(c): Deep palatal root fracture.
(d): Radiograph showing fracture line near mesial alveolar crest.

lateral condensation technique (Fig. 2). The teeth were both clinically and radiographically stable at the 3 month follow-up appointment. The gutta-percha filling was partially removed and leaving a 4 mm apical seal. A glass fiber post was placed in the root canal of left incisor (#21) and the restored the crown with composite resin (Fig. 2D).

For the right incisor (#11), electrosurgery (Martin MD 30 Minitom, KLS Martin Manufacturing, FL, USA) was used to exposed the fracture line (Fig. 2E) and a provisional endocrown with a metal post was cemented into the root canal with polycarboxylate cement (HY-Bond, Shofu, Japan), and also radiographically evaluated. The over-contoured profile at the facial gingival level of #11 was created (Fig. 3A), which allow a desirable horizontal vector of force toward the palatal direction and vertical vector of force toward occlusal direction during orthodontic extrusion of the root.

Orthodontic brackets (Standard Edgewise System, Tommy, Japan) were affixed to the teeth from #13 to #22 and intra-arch anchorage was design by splinting the teeth (Fig. 3). The bracket on the #11 was positioned more apically and labially than those on the adjacent teeth, which shall benefit for reduction of the incisal surface during extrusion and avoiding compression on the labial bone plate of the tooth. A 0.016-inch wire (Tommy) was then placed for leveling and alignment of the tooth (Fig. 4).

To minimize gingival downward growth, the supracrestal fiberotomy was conducted with the thinnest probe of electrosurgery before the time starting orthodontic extrusion, and then performed every 2 weeks during the active phase of forced eruption. The procedure of intrasulcular incisions through the junctional epithelium and the supracrestal connective tissue attachment was carried out under local anesthesia. Meanwhile, incisal and occlusal adjustments were performed (Fig. 4C), and the extruded root surfaces were curetted. The patient was prescribed with analgesics for pain relief.

Tooth leveling was completed at 6 weeks of orthodontic treatment. Conservative periodontal surgery was conducted to correct the discrepancy of gingival height, meanwhile supracrestal fiberotomy around the extruded tooth was performed again (Fig. 5). The new provisional crown of #11 was made and splinted with the adjacent #21 for stabilization to prevent relapse intrusion (Fig. 6). Overcontouring modification of the #11 provisional crown at gingival level was performed to accommodate the new gingival embrasure space generated from the erupted tooth, because the narrower root portion of the erupted tooth was exposed. The stabilization period was planned for 4 months. However, the patient

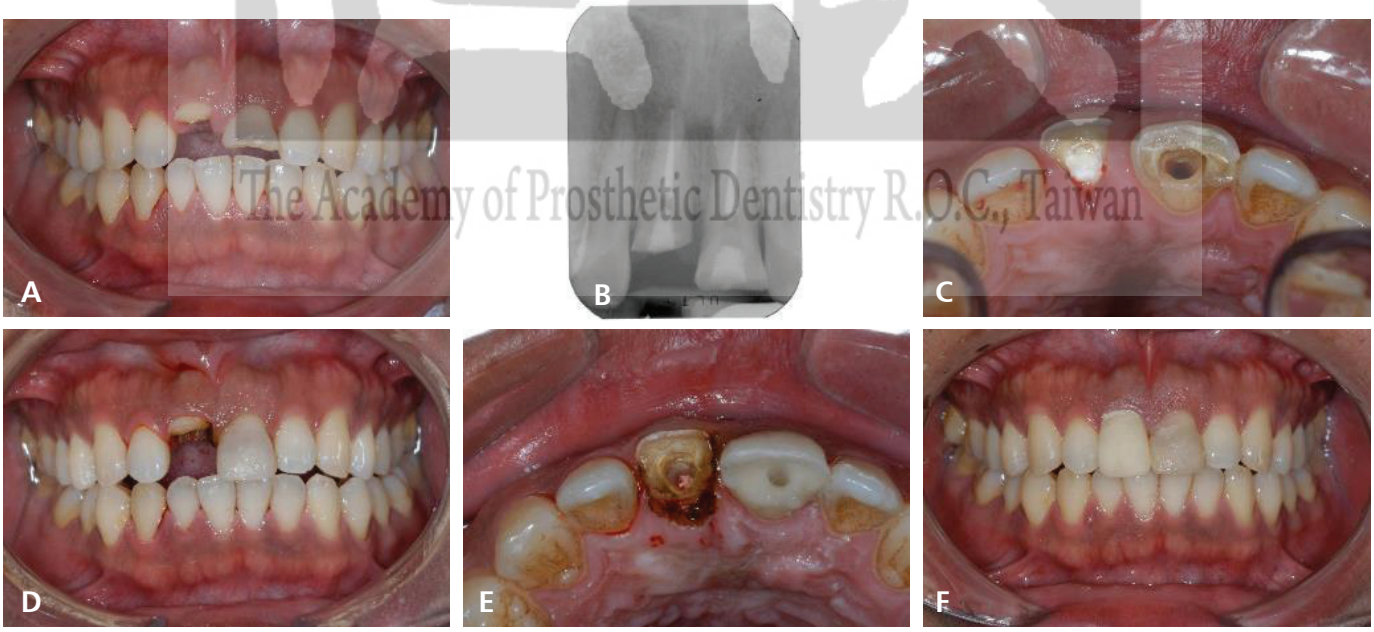

Figure 2. Endodontic treatment and provision crown fabrication.
(a): Healing of gingival tissue.
(b): Radiograph showing completeness of root canal treatment.
(c): Post space preparation for left central incisor.
(d): Delivery of provisional crown for left central incisor.
(e): Electrosurgery to exposure fracture line.
(f): Delivery of provisional crown for right central incisor.

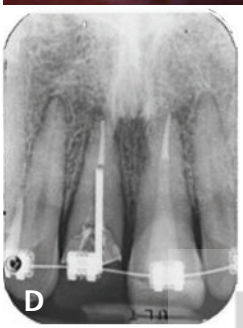

Figure 3. Start orthodontic extrusion of the root-fractured central incisor.
(a): Overcontouring of provisional crown for right central incisor.
(b): Insertion of brackets and wire and start extrusion of right central incisor.
(c): Oblique view showing overcontoured profile at cervical zone of right central incisor.
(d): Radiograph showing endocrown with metal post inserted.

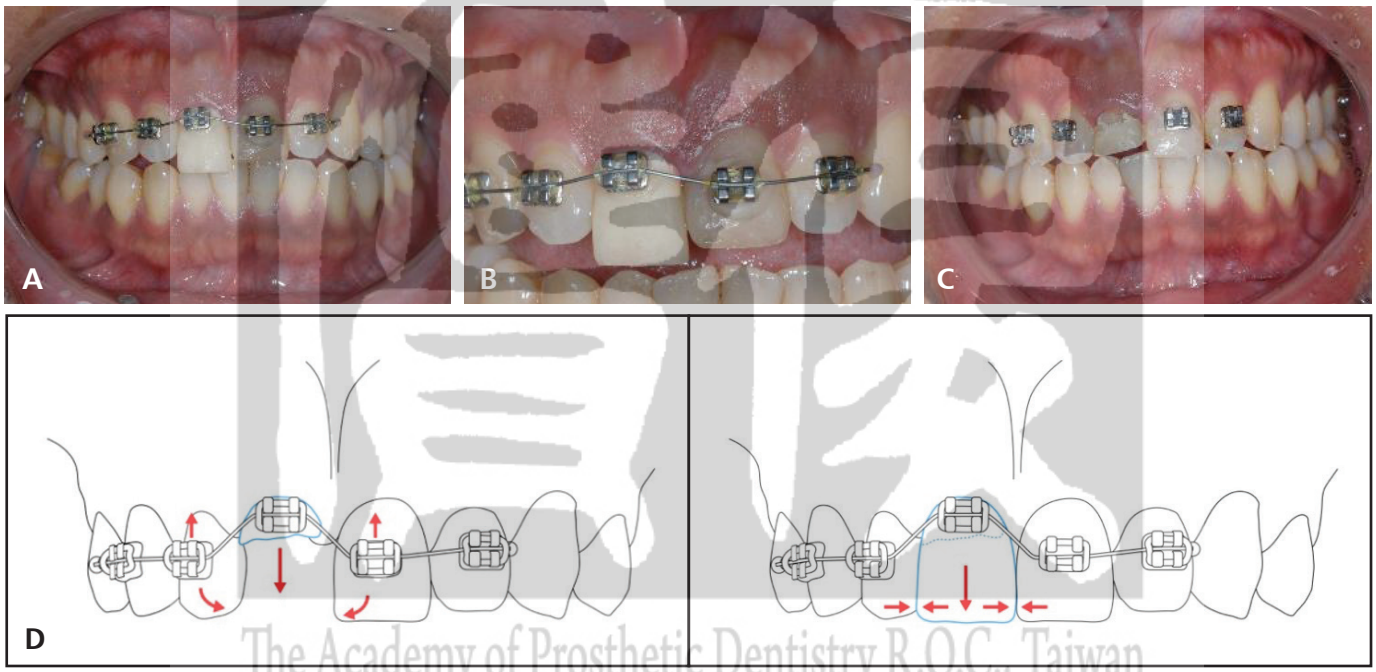

Figure 4. During orthodontic extrusion of the root-fractured central incisor.
(a): Extrusion of the fractured tooth.
(b): Gingival downward growth of the extruded tooth.
(c): Incisal and occlusal adjustment for the extruded tooth.
(d): Temporization of the fractured root providing esthetics and reducing the risk of inward tipping of adjacent teeth during orthodontic extrusion of the root.

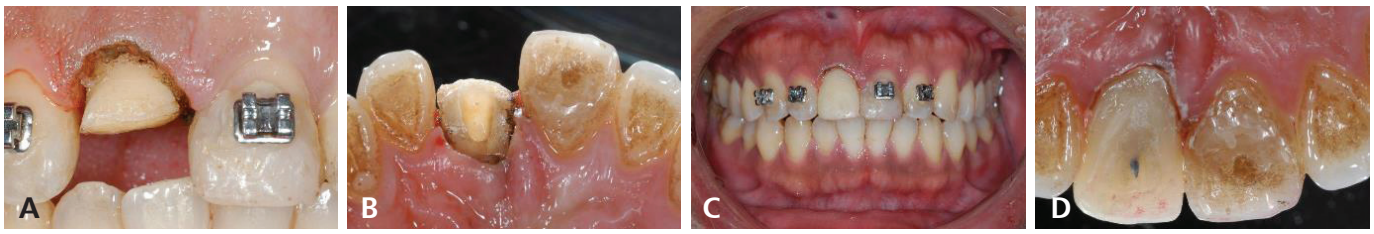

Figure 5. Fiberotomy during orthodontic extrusion.
(a): Facial view of fiberotomy of the extruded tooth.
(b): Palatal view of the extruded tooth.
(c): Facial view of new provisional crown of the extruded tooth.
(d): Palatal view of new provisional crown of the extruded tooth.

did not begin the treatment plan due to a personal matter and waited for 10 months. At that time, periodontal sounding and periapical films found that the bone height was unchanged. The overall tooth extrusion was about 3 mm and the gingival height had increased approximately 2 mm (Fig. 4B). A gingivectomy was performed to even the gingival height of both central incisors, emergence contour of #11 was adjusted accordingly. At the follow up appointment after gingival maturation, #11 provisional endocrown was removed, and the tooth was installed with a fiber post and resin core (Fig. 5). Then, tooth preparation of #11 and #21 was performed with a circumferential chamfer margin configuration. Since subgingival overcontouring of #11 was indicated for the narrower root, the margin finalization for #11 was more conservatively (Fig. 7A). Impressions were made with vinyl polysiloxane impression material, and splinted ceramic crowns (IPS e.max Press; Ivoclar Vivadent) of #11 and #21 were cemented with resin cement. The results of a 14-years of follow up demonstrated good esthetic results and periodontal health of #11 with a mild discrepancy of free gingival margin between the central incisors clinically. Root resorption at apex of #11 was noted in the radiographic examination (Fig. 7).

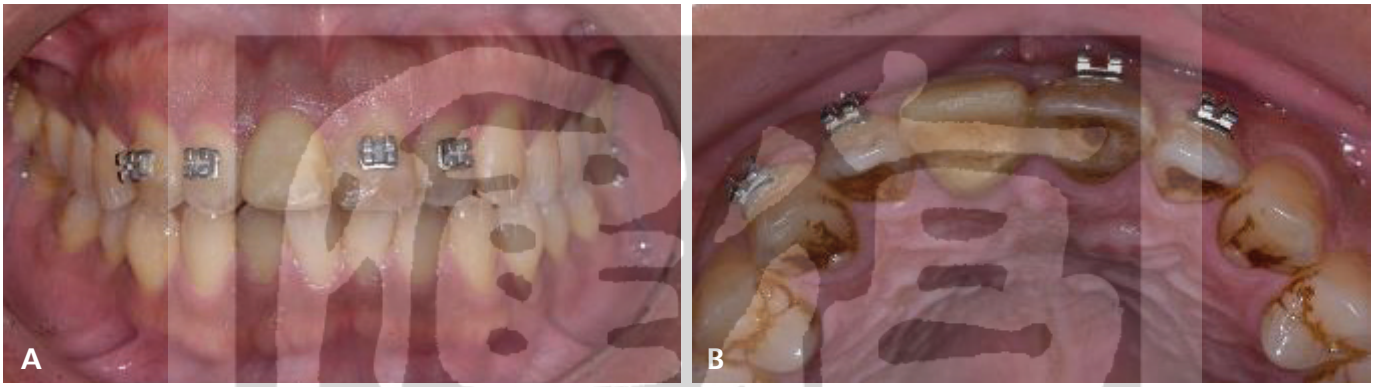

Figure 6. Stabilization of extruded tooth with resin bonding to adjacent provisional crown after orthodontic extrusion.
(a): Facial view. (b): Palatal view.

Figure 7. (a): Final preparation of central incisors.
(b): Delivery of splinted ceramic crowns at delivery.
(c): Radiograph showing apical root resorption at delivery.
(d): Front view of splinted ceramic crowns at 3 years of follow up.
(e): Front view of splinted ceramic crowns at 14 years of follow up.
(f): Radiograph showing stable bone height at 14 years of follow up.

Discussion

Fracture teeth are a common problem following accidents, and the position of the fracture line dominates the subsequent dental management and treatment plan. Orthodontic extrusion is a useful tool to relocate the fractured margin to provide a sound ferrule and biologic width while restoring teeth. In this case report, we address the importance of the preservation of labial bone plate of the traumatized central incisor. Undesirable excessive extrusion force may create an undesirable horizontal vector of force toward the labial direction and cause bone resorption (Figs. 8A & 8B). Previous studies had shown the labial bone plate of incisors is relatively thinner than the palatal bone, and usually less than 1 mm thick at marginal bone [10,13,14].

To reduce the risk of labial bone resorption, couple of methods can avoid the undesirable horizontal vector of force to erupt the tooth labially. Especially in the esthetic zone, a well-designed multiple-loop orthodontic appliance with adequate torque control is highly recommended [15-17]. The lingual orthodontic technique is another modality for forced eruption therapy that provide favorable horizontal vector of force and esthetic needs [18]. Nozawa et al.[10] demonstrated that forced eruption combined with buccal root torque could induce buccal and coronal bone augmentation around an irretrievable tooth. Further, orthodontic extrusion of a fractured root utilizing a custom-made intra-canal wire loop or hook also showed a promising result if the force is applied along the tooth axis [19,20]. However, forced eruption of the fractured root without temporization compromised the esthetics

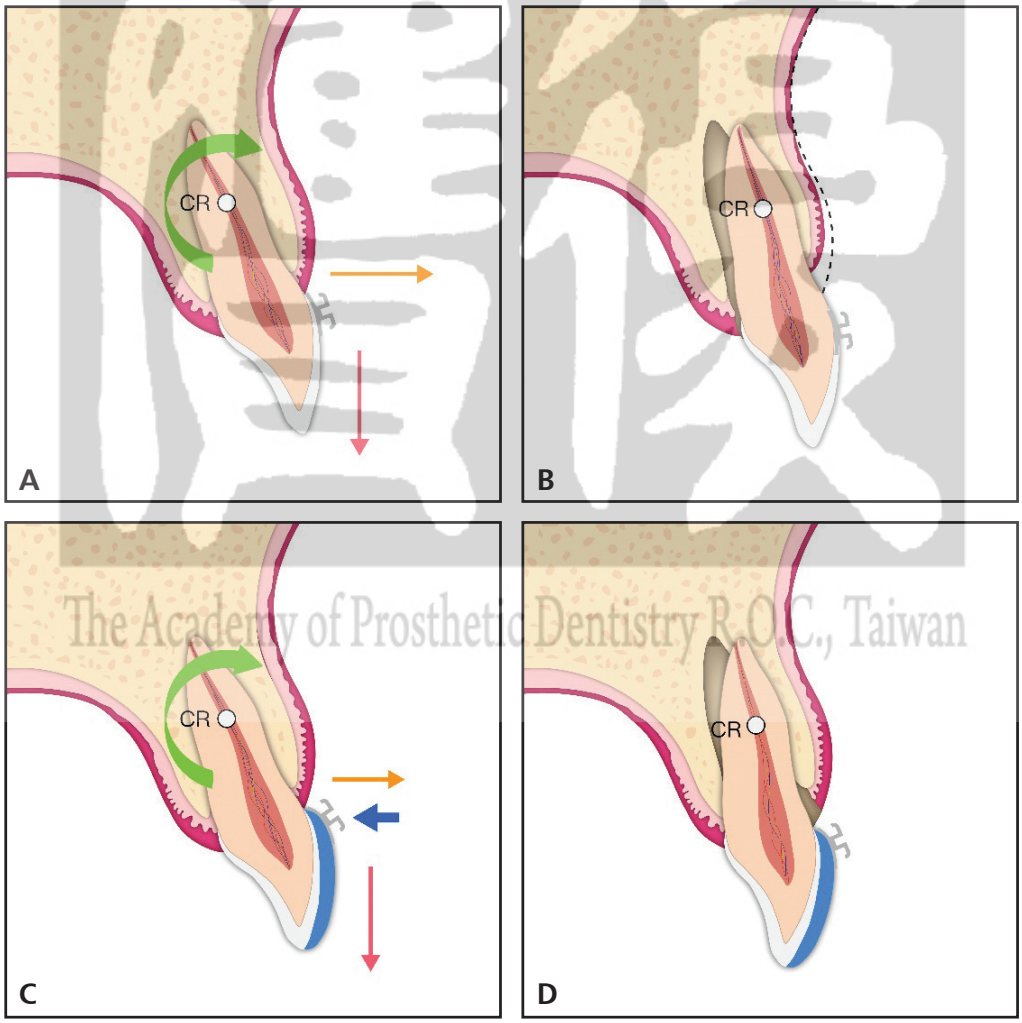

Figure 8. (a): Extrusion force is not through the center of rotation (CR), which causes clockwise rotation of the tooth.
(b): Vertical vector of orthodontic force causes tooth extrusion, while horizontal vector could cause labial bone resorption and marginal gingiva recession.
(c): Thickening the buccal wall of provisional restoration provides palatalized vector (blue arrow) during orthodontic extrusion.
(d): Increasing palatalized vector during orthodontic extrusion reduced the risk of labial bone resorption and marginal gingiva recession.

and could induce tipping of the adjacent tooth (Fig. 4D). To avoid any possible undesired pressure force applied on the fragile labial bone plate, Hochman et al.[15] showed a sophisticated example of orthodontic extrusion using a provisional restoration with intracoronal elastics to apply a force through the long axis of a tooth. Instead, this case report presented a simple way to protect the labial bone plate and provide certain function of esthetics by using a provisional Endo crown with an additive contour at the facial gingival level (Figs. 8C & 8D). The outcome of the extruded #11 showing a stable labial tissue profile was promising (Figs. 7E & 7F). However, it is noteworthy that the forward clockwise moment during orthodontic extrusion will cause the root apex to be driven in a facial direction and cause possible bone perforation. Therefore, case selection is critical when adopting this technique [13,15].

The force necessary to extrude a tooth majorly depends on the root morphology, and amount and density of bone on the tooth to be extruded. Therefore, the exact amount of force optimal for tooth extrusion could not precisely estimated. A wide range of extruding forces were suggested by previous references. The force can be as low as 15-30 g to extrude the tooth [21,22], and as high up to 80 g for the tooth with a long root and dense bone surrounding [15,23]. There is no consensus on the rate of tooth extrusion in published studies, since slow or rapid forced eruption will achieve different periodontal implications. There will be compensatory growth of bone and soft tissue if the root is extruded slowly as 1 mm per month, while the tooth can be extruded from the alveolar bone without significant bone deposition if the root is extruded rapidly as 1 mm per week [24,25]. In this case, to minimize bone downward growth after forced eruption, rapid extrusion with supracrestal fiberotomy was proposed. Further, the fiberotomy procedure was also beneficial to limit the relapse intrusion of the extruded root. However, some discrepancy between the gingival margin level of the treated tooth and the adjacent teeth was found in this case, which is in line with our projections and related references [26,27]. Because supracrestal fiberotomy is unable to completely prevent displacement of the gingival attachment, additional orthodontic therapy or surgical correction may be necessary. In this case, the discrepancy between adjacent gingival levels was corrected by a conservative gingival surgery [27,28].

Closely monitoring the periodontal response during forced eruption is mandatory. According to the fundamental rule of the biologic width, at least 3 mm of sound dental tissue above the alveolar bone crest should be extruded. At the completion of forced eruption achieving the desired amount of extrusion, the tooth must be stabilized for hard and soft tissue maturation and to prevent relapse intrusion. Since soft tissue growth may be visible during the stabilization period, the longer the stabilization period, the more likely such growth will occur. In this case, minor periodontal surgery might be necessary to remove gingival or even bony excess. In this case, the extruded #11 was splinted with #21 provisional crown to maintain stabilizing force against root intrusion for 10 months, as previous references suggested one month of stabilization for every millimeter of extrusion [25,29,30]. In order to minimize relapse, supracrestal fiberotomy immediately prior to the initiation of the stabilization period is highly recommended [31]. Using a scalpel to perform supracrestal fiberotomy is a common way, while electrosurgical fiberotomy was adopted in this case for easy bleeding control [32,33]. The procedure did not interfere with the outcome of periodontal health and orthodontic extrusion. Recently, laser fiberotomy has gained more attention in clinical and laboratory studies [34-36], and their results seem to be encouraging.

Lingualized movement of #11 during orthodontic extrusion not only minimized the risk of labial bone plate resorption or dehiscence, but also generated space for the future restoration (Fig. 8D). Therefore, tooth preparation for the extruded tooth can be kept as minimum as possible to preserve tooth structure. However, it should be noticed that the projection of the final restoration should be carefully judged at the early diagnosis and treatment for the fractured tooth. The location of fracture line decides the final crown-root ratio of the tooth, while the root form at the point of fracture dominates the emergence profile and the final esthetics. A tapered or narrow root form will produce a narrow neck on the final crown. Although crowns with an increased contour beneath gingiva can be fabricated to improve the emergence profile, there is a potential risk of gingival recession or interproximal bone loss facing overcontoured restorations. In this case, the esthetics was compromised to strive for the optimal periodontal health. An emergence profile favorable to periodontal tissue was designed for

#11 crown. The narrow emergency profile of the crown, comparing to the adjacent incisor (Fig. 7E), induced a complimentary growth of gingiva in to the emergence zone was observed at the 14 year follow-up (Fig. 7D). However, clinical and radiographic findings revealed a healthy condition of soft tissue and hard tissue. The soft tissue color and texture at the labial aspect of the extruded incisor mimicked that of the contralateral incisor, including an adequate width of keratinized gingiva, and the patient was pleased with the favorable esthetic result.

The limitations of this technique should be mentioned that the bracket on the overcontoured provisional crown may result in undesired gingival irritation and cause a loss of the normal self-cleansing morphology of the tooth, resulting in potential periodontal problems. The rapid extrusion with fiberotomy, although was an efficient way to reposition the fractured margin, the possible trade-off in root resorption should be reconsidered. Another possibility of root resorption observed in this case may have been caused by the tipping movement, which merits further exploration and study.

Conclusion

This case report presented a simple and effective technique to extrude the central incisor with a complicated crown-root fracture. With carefully case selection, the labial hard and soft tissue can be persevered, which not only benefits the crown restoration for the fractured roots but also provide a good bone housing for the future implant. Mastering this technique of orthodontic extrusion is a valuable aid to the interdisciplinary practice because they offer predictable results for prosthodontists.

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The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

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