Forced Eruption by Fiber-Reinforced Composite

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LEARNING OBJECTIVES:
After reading this article, the individual will learn:

- The scientific and clinical rationale for forced tooth eruption.
- A clinical technique for achieving forced tooth eruption without the use of orthodontic brackets.

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INTRODUCTION
Teeth with defects in the cervical third of the root and which require a full coverage restoration present a challenging dental treatment situation. In these cases forced eruption permits crown margins to be placed on sound tooth structure. Two methods are available for forced eruption: with and without the use of orthodontic brackets.

This article reviews the literature on the topic of forced tooth eruption, and presents a clinical case in which a newly designed appliance utilizing fiber-reinforced composite (FRC) without orthodontic brackets was used to achieve forced eruption.

Forced eruption was first introduced by Heithersay and then followed by Ingber for the correction of alveolar bony defects.1-3 Although the primary aim of this treatment has been the correction of bony defects, it is currently used in clinical crown lengthening of fractured teeth or teeth with subgingival decay.4,5 Fracture of teeth at or below the alveolar bone crest present certain restorative complications if restored without correction of the defects.6 Maintenance of biologic width is vital during prosthodontic treatment, and encroachment on this width can cause gingival inflammation, attachment loss, pocket formation, and subsequent bone loss.7-11

There are 4 treatments that can be used for maintenance of biologic width: tooth extraction and replacement, crown lengthening surgery, moving the tooth by surgical extrusion, and forced eruption. Tooth extraction seems to be the easiest method, but this requires costly prosthodontic or implant placement, and often can present aesthetic challenges in the anterior region. Crown lengthening surgery is also useful for posterior teeth because no aesthetic considerations are necessary.2,3,12-14 Surgical extrusion of teeth was first introduced by Kahnberg,15 with the procedure consisting of moving the tooth by surgical approaches and fixing it in a new
Forced eruption is one of the easiest orthodontic approaches that can have an acceptable outcome and prognosis, and has a low incidence of relapse. Orthodontic forces cause a tension in the periodontal ligament and create a wider periodontal space. This tension stimulates osteoblastic function, and consequently, bone formation will occur in situ. The rate of tooth movement serves as the main determinant of the amount of bone formation and alveolar bone movement. If the tooth is moved slowly (1 to 2 mm per month), alveolar bone crest will move with the tooth and the clinical crown will show no changes in size. However, if the tooth is moved at a faster rate (3 to 4 mm per month), forces can tear periodontal ligament and cause the tooth to extrude from the alveolar bone. However, using heavy forces or very fast movements can also cause tissue damage or ankylosis. It must be considered that if residual ligaments are not cut by fibrotomy, their presence can cause some extent of bone formation at the alveolar crest.

Selection of the movement rate depends on the aim of the treatment. Tooth fracture management mandates the fast option, while for the correction of bony defects, bone augmentation for the reconstruction of interdental papilla, or implant insertion, the slow movement is preferred.

Certain considerations must be taken into account regarding forced eruption, including: root length, where after movement the tooth must have a proper crown/root ratio; root shape, where wider roots are more appropriate because tapered roots may compromise aesthetics in the cervical aspect of prostheses; importance of the tooth, eg, it is more important to preserve a root in young people with full dentitions compared to partially edentulous elderly patients; position of the fracture, eg, if the fracture occurred at least 3 mm under alveolar bone crest, treatment would be more complicated; and aesthetics, eg, if the gingival line is placed in the aesthetic zone, root preservation can improve gingival aesthetics.

Three points must be considered when determining the amount of tooth movement desired: defect position; required space for prosthetic crown margin (about 1 mm); and required space for biologic width maintenance (about 2 mm). There are different alternative methods proposed for tooth movement in forced eruption. Simon suggests bonding a wire to adjacent teeth and transferring the force by elastic from the wire to the root. The primary advantage of this method is simplicity. Nappen performed forced eruption by bonding brackets to the target tooth and adjacent teeth using nickel titanium wire with high elasticity potential, which has the tendency to return to its straight form, moving the tooth with it. Osterle placed a temporary crown on the residual root and placed a hook over the crown, then used elastic to connect the hook to the wire bonded to adjacent teeth. Segelnick used a C clasp with an occlusal rest and transitional arm. Other methods involve the use of removable appliances and magnets.

Forced eruption has 4 main stages: (1) proper case selection, root canal therapy, and appliance fabrication; (2) force application (the force needed for 1 mm of tooth movement in a week is about 25 to 30 grams in rapid movements. About 4 weeks is needed for the desired amount of movement, and the patient must be followed once or twice a week for prevention of gingival inflammation and elimination of occlusal interferences); (3) maintenance period (there are different suggestions about the duration of this period, but it is well known that 3 to 6 weeks is the required time for ligament reconstruction. Fibrotomic surgery can be performed before, during, or after the tooth moving procedure); and (4) Prosthetic treatment (4 to 6 weeks after osseous surgery, and 2 to 4 weeks after soft tissue shaping is the required healing time for prosthetic treatment).

The following case report introduces a new method for forced eruption, which includes some modifications to the conventional technique. Some of the advantages of this method are aesthetic maintenance during the treatment period, no need for occlusal adjustments, simplicity, low cost, and stability of the treatment outcome (no relapse).

CASE REPORT

A 25-year-old female with a fracture in the right maxillary central incisor was referred to the dental school, Shiraz University of Medical Sciences. A horizontal root fracture had occurred at the level of the alveolar crest. Adjacent teeth had no decay or restorations, and...
Radiographs showed that the fracture did not extend beyond the crest level. The tooth had been endodontically treated previously. There was not enough tooth structure for restoration without invasion of the biologic width (Figure 1). Different treatment options were discussed with the patient, including tooth extraction and replacement by a fixed partial denture or implant prosthesis, crown lengthening surgery, or forced eruption. Because the patient had a gummy smile, the extraction of the root followed by fixed partial prosthesis treatment was not considered a good treatment option. Further, the patient was not willing to have sound tooth structure removed from adjacent teeth for prosthodontic preparation. Crown lengthening surgery would have resulted in discrepancies of the gingival level and the loss of interdental papillae, which was not aesthetically pleasing. Use of an implant would be relatively costly in terms of the patient’s financial situation. Following thorough descriptions to the patient regarding all treatment options, she preferred the forced eruption technique.

Because the tooth had previously undergone root canal therapy, the coronal 3 mm of gutta-percha was removed. A piece of wire (0.032 inch in diameter) in the form of a loop was fixed into the prepared root using glass ionomer cement. Another loop was formed at the other end of the same wire. The FRC tape (Thinner Higher Modulus, Ribbond) was passed through this latter loop (Figure 2), and the complex was bonded to the adjacent teeth. The proper distance of the 2 loops (the one placed into the canal and the loop attached to the FRC) should be determined prior to the placement of the complex. The internal diameter of the bracket’s elastic (O ring), which served as the major force exertion during treatment, was measured to be 3 mm while active. Therefore, it was decided to set a 5 to 6 mm distance to provide the possibility of a 3 mm tooth movement.

To bond the FRC-loop complex to the adjacent teeth (maxillary left central incisor and right lateral incisor), the proximal surfaces of the crowns of these teeth were first cleaned with fluoride-free pumice and spot etched using 37% phosphoric acid for 20 seconds. Etched surfaces were then irrigated and dried. Bonding agent (Single Bond, 3M ESPE) was applied and light cured for 20 seconds. Fiber was immersed into a hydrophobic resin and saturated.
Fiber, containing the loop, was then placed on the proximal surfaces of the adjacent teeth and light cured. To strengthen the complex, FRC was covered with flowable composite resin and cured (Figure 3).

To provide aesthetics during treatment, a labial veneer shaped as the labial face of the central incisor was fabricated from particulate filled composite resin (shade A3, Z250, 3M ESPE) and attached to the FRC within the edentulous area (Figures 4a to 6). Deficient space and a deep bite required placement of the hook-FRC complex with a slight distal inclination. The 2 hooks were connected to each other by an O ring elastic bracket, and oral hygiene instructions were given to the patient (Figure 7).

The patient had been referred from another city and it was not possible for her to travel to the dental school for adjustments, so a dentist in her area was asked to change the elastic every 3 to 4 days. After 29 days, 3 mm extrusion was observed in the mesial, distal, and palatal surfaces, but the extrusion on the labial surface was less than 3 mm (Figures 8 to 10). Although in this stage the hooks were closer to each other, for the maintenance period the same elastic was used to connect them. Internal bevel gingivectomy and circumferential fibrotomy were performed after 10 days to detach the attachment apparatus moved during extrusion (Figure 11). For this reason the FRC-hook complex and adjacent temporary crown were removed, and for aesthetic reasons during the healing period another appliance was designed to cover the edentulous area. For this purpose an impression with alginate was taken and poured in orthodontic stone before the surgery and after removing the FRC complex. Then a removable orthodontic appliance (including 2 Adams clasps on the first maxillary molars and an acrylic tooth in the edentulous area) was designed and fabricated. The acrylic tooth was prepared to avoid applying pressure on the dressing following the surgery (Figure 12).

One week later, the sutures and the dressing were removed, and the prosthetic phase of treatment followed. The removable appliance was used during fabrication of the final restoration. To provide aesthetics, a full ceramic restoration was the best alternative, but the patient’s deep bite led to the decision to restore the tooth with a PFM crown in order to place the occlusal contact on the metal portion. The patient’s social circumstances caused a
14-week delay between the maintenance period and prosthesiscementation stage, which was longer than necessary, but unavoidable (Figures 13 and 14).

**DISCUSSION**

After tooth fracture, forced eruption is the technique of choice if conditions are appropriate and the patient is motivated. This method is also useful in the management of decay, internal root defects, bony defects, and periodontal pockets. Contrary to conventional orthodontic treatments, the purpose of this method is not the correction of tooth position in the arch; it is to preserve the root and biologic width.

Soft tissue and bone also move during extrusion. To prevent this movement, it is proposed to make a sulcular incision at each appointment. The incision can also be made before the tooth movement or before the maintenance period. In our case it was performed after tooth movement. However, there is not enough evidence to indicate the influence of fibrotomy on the required time for maintenance.

In some methods, a transitional crown or the fractured part of the crown is attached to the root to provide aesthetics during the treatment and to prevent adjacent teeth from tipping into the edentulous space. The primary disadvantage of this method is movement of the temporary crown during the root extrusion, and as a consequence, occlusal adjustment would be necessary at each appointment. But in the method described in this article, the transitional crown is attached to adjacent teeth and does not move during extrusion. Further, spot etching results in minimal enamel involvement in the adjacent teeth.

The extrusion rate in this case is in agreement with another studies. After 29 days, tooth movement was estimated at 3 mm (about 1 mm in 10 days). Heavy extrusion forces can cause pulpitis, root resorption, bony defects, and periodontitis and none of these pathologic conditions were observed in this case.

For forced eruption, force application from the palatal side creates a vertical force direction, which provides a more proper angulation compared to a wire or bracket attached to the buccal aspect of the tooth. However, in this case, regarding the buccal tendency of force direction, the tooth movement in the buccal aspect was less than the palatal aspect, but this did not make a significant clinical difference.

In the literature, different durations have been suggested regarding the maintenance period. A deficient maintenance period can produce unwanted results; however, compared to the other orthodontic
movements, the method described in this case has less tendency to relapse.\textsuperscript{7} Lemon\textsuperscript{34} described that one month would be the proper maintenance period for 1 mm of extrusion.\textsuperscript{34} However, Simon\textsuperscript{35} believes that 7 weeks is the required time for periodontal ligament repair,\textsuperscript{35} and Andreasen\textsuperscript{36} observed that 1 week of splinting is adequate for an avulsed tooth.\textsuperscript{36} In our case, the maintenance period (from the beginning of maintenance to final cementation of the prosthesis) was about 3.5 months, and no untoward outcomes were encountered.

Home care and oral hygiene are important considerations in this method. Inadequate hygiene during treatment could result in gingivitis, periodontitis, and/or destruction of bone.

This appliance and technique incorporate some modifications to traditional devices, and can provide proper aesthetics, function, and stability using a relatively simple procedure that can be performed by the specialist or general practitioner.

**CONCLUSIONS**

Forced eruption is often the most ideal option to restore fractured teeth, especially in the anterior segment. The advantages of this approach include preservation of the root structure, enhancement of the gingival level and aesthetics of the fractured tooth and adjacent teeth, and significantly less cost compared to implant treatment. Although the treatment is quite time-consuming, it requires almost the same time as needed for implant therapy. Home care and oral hygiene have a key role in treatment success. Using these small appliances for forced eruption can eliminate the need for fixed prosthesis appliances, and provide aesthetics and function as acceptable as comparable techniques, using a relatively simple procedure.

**REFERENCES**

Forced Eruption by Fiber-Reinforced Composite


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3. Optional treatment for the maintenance of biologic width includes:
   a. crown lengthening surgery.
   b. tooth movement by surgical extrusion.
   c. forced eruption.
   d. all of the above.

4. In forced eruption, which rate of tooth movement moves the alveolar bone crest with the tooth, with no change in size of the clinical crown?
   a. 1 to 2 mm per month  
   b. 3 to 4 mm per month  
   c. 4 to 5 mm per month  
   d. 5 to 6 mm per month

5. Fast tooth movement during forced eruption is preferred for which of the following:
   a. correction of bony defects.
   b. bone augmentation for reconstruction of interdental papilla.
   c. management of tooth fracture.
   d. implant insertion.

6. In forced eruption, about 12 weeks is needed for the desired amount of tooth movement. The patient must be followed once or twice a week for prevention of gingival inflammation and elimination of occlusal interferences.
   a. The first statement is true, the second is false
   b. The first statement is false, the second is true
   c. Both statements are true
   d. Both statements are false

7. For forced eruption, force application from the palatal side creates a vertical force direction. This provides a more proper angulation compared to a wire or bracket attached to the buccal aspect of the tooth.
   a. The first statement is true, the second is false
   b. The first statement is false, the second is true
   c. Both statements are true
   d. Both statements are false

8. With forced eruption, the required time for ligament reconstruction is:
   a. 1 to 2 weeks.
   b. 2 to 4 weeks.
   c. 3 to 6 weeks.
   d. 8 to 10 weeks.
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3. ☐ a  ☐ b  ☐ c  ☐ d  7. ☐ a  ☐ b  ☐ c  ☐ d

4. ☐ a  ☐ b  ☐ c  ☐ d  8. ☐ a  ☐ b  ☐ c  ☐ d

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