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A Multidisciplinary Approach to the Management of a Subgingivally Fractured Tooth: A Clinical Report

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Keywords
Tooth fracture; biological width; crown lengthening; forced eruption; esthetics; fibrotomy.

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Accepted April 30, 2010

doi: 10.1111/j.1532-849X.2010.00682.x

Abstract

Anterior tooth fracture is the most common type of trauma occurring to the dental tissues. Teeth fracturing at or below the gingival level usually have a poor prognosis, with extraction of the tooth being the most probable outcome. Clinical crown lengthening followed by prosthetic rehabilitation is a promising approach toward such cases. The clinical report presented here explains in detail the various treatment modalities available for such cases with special emphasis on orthodontic extrusion/forced eruption.

The most common type of trauma occurring to the dental tissues is anterior tooth fracture because of the location and prominence in the arch. Most commonly, crown or root fractures with or without exposure of the pulp affect the maxillary anterior teeth, whereas the mandibular anterior teeth are least or rarely affected. Such teeth need endodontic therapy, followed by a prosthetic rehabilitation with dowel placement and crown fabrication; however, fracture of a tooth below the gingival attachment or crest of the alveolar bone presents a very difficult restorative problem, and such fractured teeth were often considered hopeless and were consequently extracted.[1] This is because tooth fractures close to the gingival margins (as well as subgingival fractures) usually do not allow a 2-mm ferrule design without violating the biological width. Gingival biological width (biologic membrane, dentogingival attachment) is the area of gingiva attached to the surface of the tooth coronary to the alveolar bone. This determination is based on Garguilo et al's 1961 study[2] on the dentogingival junction of cadavers. They studied 287 teeth of 30 cadavers and established the relationship between marginal alveolar bone, connective tissue attachment (CTA), epithelial attachment (EA), and gingival sulcus (GS). Results showed the mean connective tissue attachment is 1.07 mm, epithelial attachment is 0.97 mm, and dental sulcus is 0.69 mm. Gingival biological width (GBW) was calculated by adding widths of CTA and EA: GBW = CTA + EA = 2.04 mm (Fig 1).

There are two possibilities for reestablishing the required biological width: surgical crown lengthening[3] and orthodontic extrusion (forced eruption),[1] with the former approach being more commonly recommended for such cases. The second approach, forced eruption, was first introduced by Heithersey[1] in 1973 and was later supported by Ingber in 1976.[4] Since then it has been used successfully by a number of clinicians in treating subgingival fractured anterior teeth.[5,6] Presented here is a clinical report describing the procedure of forced eruption in detail for the treatment of a subgingivally fractured permanent mandibular incisor.

Clinical report

A 12-year-old girl was referred to the Department of Pediatrics & Preventive Dentistry with a chief complaint of a missing tooth in the anterior region of the lower jaw. She wanted the missing tooth replaced by a fixed partial denture (FPD). She reported a history of trauma 9 months ago in which her mandibular anterior tooth was injured, and one of her teeth had fractured completely. Her parents disposed of the tooth and did not report to any dentist at that time. They reported bleeding, which stopped after some duration, from the site of tooth loss. The child also complained of pain for a few days following the trauma. The pain subsided after locally prescribed medication. The patient did not complain of any discomfort after this episode and was clinically asymptomatic. She reported to the dental office for the sole purpose of tooth replacement. She was in good general health, and her medical history was found to be noncontributory.

On clinical examination of the oral cavity, all teeth were present in normal compliment except the missing mandibular

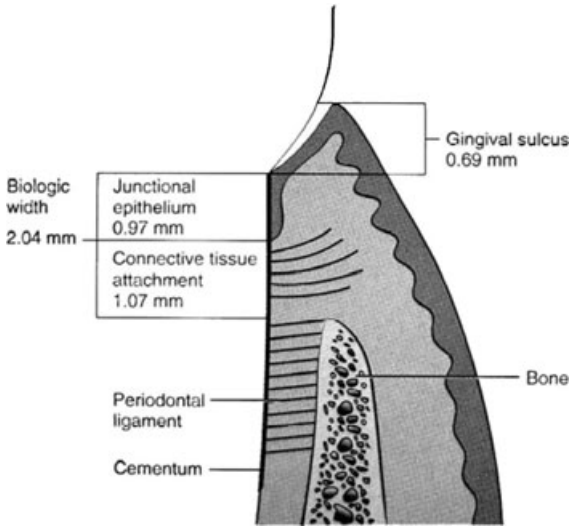

Figure 1 Representation of biologic width.

left lateral incisor (Fig 2). The gingiva at the site of the missing tooth was intact and healthy. An intraoral periapical radiograph revealed the root of the mandibular lateral incisor to be present, confirming a subgingival tooth fracture with loss of the complete crown portion. There was no apparent root fracture, and the lamina-dura around the root was intact with no signs of periapical pathosis (Fig 3). Using the Prosthodontic Diagnostic Index for completely dentate patients[7] developed by the American College of Prosthodontists, the condition was classified as Class II, moderately compromised completely dentate patient.

The treatment modalities for such cases include the extraction of teeth followed by rehabilitation with FPD replacement and preservation of tooth by either surgical crown lengthening or forced eruption. Considering the visual treatment outcomes, it was decided that the best course of action would be to preserve the tooth endodontically and restore it prosthodontically by a dowel-and-core-retained metal-ceramic crown following orthodontic extrusion.

After administering proper anesthesia, a small portion of the gingiva over the remaining root was excised to achieve an appropriate access to the root canal opening. Vital pulp

Figure 2 Clinical preoperative presentation of patient.

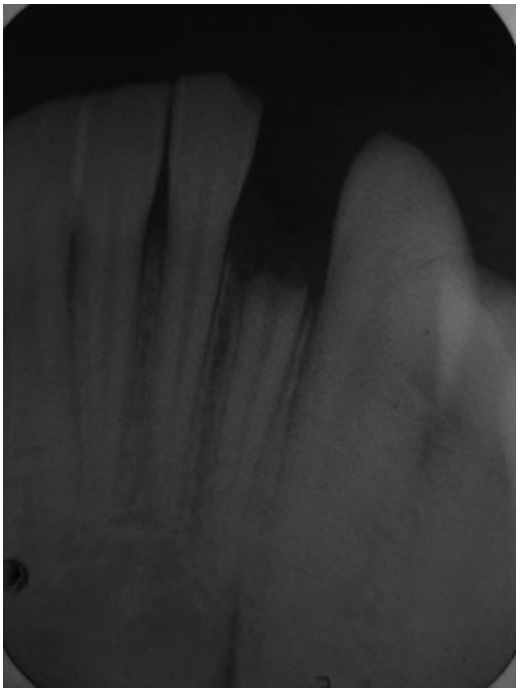

Figure 3 Radiograph depicting subgingival tooth fracture.

was found to be present in the root canal and was extirpated with the help of small size files and broaches. Working length was determined, and the canal was cleaned and shaped with intermittent irrigation using sodium hypochlorite and normal saline. The crown-down technique was used to biomechanically prepare the canal. The canal was prepared up to ISO instrument size 30 in the apical region. The root canal was dried with sterile paper points and was obturated with gutta percha and zinc oxide eugenol sealer using the lateral condensation technique. The obturation was assessed with the help of a radiograph.

The remaining tooth structure was completely below the gingival level, and thus achieving an adequate ferrule effect for crown placement would not be possible. For this reason, orthodontic extrusion, or the forced eruption, of the root was planned as the clinical crown-lengthening procedure.

After confirming the apical seal with the help of an intraoral periapical radiograph, the gutta percha was removed from the coronal and middle third of the root canal, and a

Figure 4 Position of brackets and prefabricated dowel.

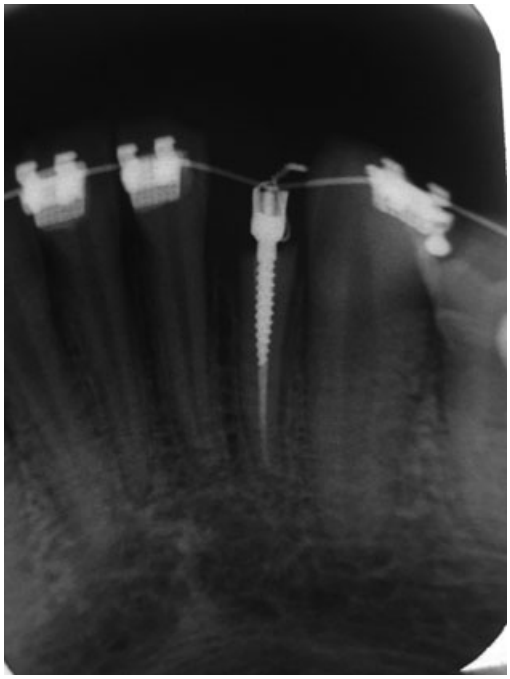

Figure 5 Radiograph of affected tooth prior to extrusion.

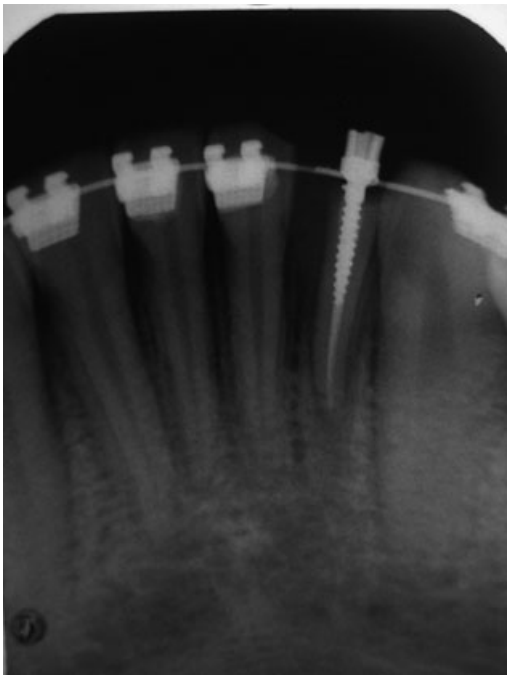

Figure 6 Radiograph demonstrating extrusion of root.

self-threading prefabricated endodontic dowel (H.Nordin SA, Montreux, Switzerland) was cemented in to the root canal. Orthodontic brackets (3M Unitek, Monrovia, CA) were placed, and the extrusive force was applied over the root by engaging the prefabricated dowel (fixed to the root) with Ni-Ti wire (3M Unitek) (Figs 4 and 5). After 4 weeks of activation, the amount of tooth movement was evaluated with the help of an intraoral periapical radiograph, and the root was found to be extruded by 4 mm (Fig 6). At this appointment it was clinically observed that the extruded tooth had moved in buccal direction (Fig 7). To correct this, lingual buttons were attached on the lingual surface of the mandibular right central incisor and the mandibular left first premolar, and elastics were attached on to them, engaging the extruded root midway (Fig 8). The patient was reviewed after 2 weeks, when the root was found to be sufficiently moved in the lingual direction (Fig 9).

After a stabilization period of 4 weeks[8] the brackets were removed, and oral prophylaxis was performed. At this time, it was observed that the gingiva around the root had also migrated coronally along with the root. For this reason supracrestal fibrotomy and gingivectomy was performed, and the patient was recalled after 1 week (Fig 10). On the next visit core buildup was done over the dowel using light-cured composite resin (Ivoclar Vivadent AG, Schaan, Liechtenstein), and the tooth was prepared for metal ceramic crown (Fig 11). Gingival retraction cord was inserted into the gingival sulcus to facilitate recording of the margins in the impression. A mandibular arch impression was made in poly vinyl siloxane impression material (Exaflex, GC America Inc. Alsip, IL), while alginate impression was made for the maxillary arch. We used the putty wash/reline technique using a prefabricated impression tray and a tray adhesive (Examix, GC America Inc.). The impressions were poured in die stone (Gresco Products Inc, Stafford, TX) and sent to the lab for crown fabrication. A provisional crown was cemented over the prepared tooth until the final restoration was complete. A metal ceramic crown was fabricated using Ni-Cr alloy (Ni: 65.2%, Cr: 22.5%, Mo: 9.5%) (Bego, Bremen, Germany) and porcelain (Vita, Bad Sackingen, Germany). During the subsequent appointment, the final crown was cemented over the prepared tooth using type I luting glass ionomer cement (GC Corporation, Tokyo, Japan), and occlusion was checked to correct any premature contact (Fig 12). The esthetics and function were also evaluated. The patient is on a recall schedule for 1 year and has reported asymptomatically.

Discussion

Traumatic, pathologic, or iatrogenic destruction of the clinical crown often results in insufficient sound tooth structure for the placement of restorative margins that do not violate the biologic width. Three options are available for these situations: surgical crown lengthening, extraction with subsequent prosthetic replacement, or forced eruption of the involved tooth to expose sound tooth structure.[9]

Surgical crown lengthening is the most commonly employed procedure for this purpose as it is a simple and less time-consuming method, but if case selection is not appropriate, the method is not free from undesirable consequences. The complications after surgical clinical tooth crown lengthening can be summarized as:[10,11]

- Unsatisfactory esthetics, especially in the anterior tooth area:
  - Gingival retraction
  - Change of marginal gingiva contour
  - Possible loss of gingival papilla

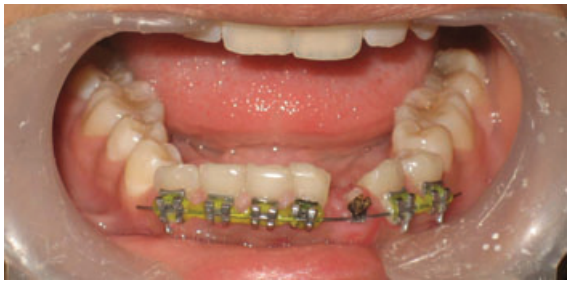

Figure 7 Unfavorable buccal movement of tooth.

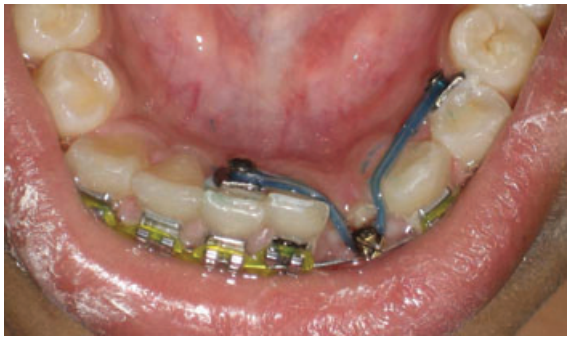

Figure 8 Placement of lingual attachments.

- Opening of inter-dental spaces
- Clinical tooth crown higher than adjacent teeth

- Unfavorable crown-root relationship
- Loss of periodontal ligament and marginal bone of adjacent teeth.

To avoid the negative consequences of surgical crown lengthening, orthodontic tooth eruption should always be considered, especially in esthetic areas. There are two methods of orthodontic extrusion—slow and accelerated. In slow orthodontic extrusion, light forces are applied, and during this process all periodontal structures (gingiva, periodontal ligament, and alveolar bone) are also extruded along with the root or tooth. As a result, the distance between the marginal bone and the fracture line does not change. Since the periodontal structures follow the moving root/tooth, to clinically expose the tooth structure,

Figure 9 Final position of the dowel and fragment.

Figure 10 Fragment after supracrestal fibrotomy and gingivectomy.

Figure 11 Tooth prepared for metal ceramic crown.

a surgical procedure is required in which the gingiva and alveolar bone, if required, is resected, and the biological width is reestablished. An advantage of slow orthodontic extrusion is that the loss of periodontal structures of adjacent teeth could be avoided, and the original bone and gingival level may be left unaltered. This method is usually applied to reduce depth of periodontal pockets in case of vertical bone loss and can also be used to increase the height of alveolar bone and gingival level in the area of roots/teeth having unfavorable prognosis for which extraction followed by an implant is planned.[12,13] In accelerated orthodontic rapid tooth extrusion, the tooth is pulled from the alveola while marginal bone and periodontal structures do not move, which is achieved through larger magnitude of force. Along with this, fibrotomy, that is, cutting of connective tissue attachment fibers, is performed every 7 to 10 days to maintain

Figure 12 Postoperative presentation after metal ceramic crown placement.

inflammation of this area (near marginal bone) so as to prevent coronal migration or growth of marginal bone after moving the root/tooth.

In the present case, the accelerated orthodontic eruption was used to extrude the root. Higher forces were applied for 1 month so as to achieve the required amount of extrusion. A problem encountered in our case was the buccal movement of the root, which was later corrected. A similar problem was also reported by Heda et al[14] in their attempt to extrude a subgingivally fractured maxillary central incisor. To avoid this problem, the treatment procedure should be planned properly, and care should be taken to avoid any buccal vector of force while extruding the tooth. A full-arch mechanics rather than sectional-arch mechanics would have given a more predictable result, as it allows the clinician better control over the forces. To avoid any undesirable movements of the adjacent teeth, the arch should be stabilized with a stiffer stainless steel wire, and then an auxiliary wire may be used to cause movement in the root/tooth to be extruded. To avoid any uncontrolled movement of the root/tooth to be extruded (like buccal movement in our case) the forces applied on the tooth should be vertical (along the long axis of the tooth).[15] To achieve this, a step-in and step-out bend in the stiff stainless steel arch wire in the region of the tooth/root to be extruded should be made so that the extrusive forces may be directed along the long axis of the root/tooth.

When the tooth is moved to its new position, the supracrestal fibers stretch and may apply force on the tooth to bring it back to its original position. This is the main cause of relapse in these cases. Thus to prevent relapse, supracrestal fibrotomy is advised, and in our case supracrestal fibrotomy was also performed at the end of the active treatment to retain the obtained results.

Crown:root ratio is an important factor in determining the amount of extrusion that can be safely achieved. It is imperative to maintain an appropriate crown:root ratio (at least 1:1 after extrusion) to provide a favorable prognosis for the restored tooth. A less than optimum crown:root ratio increases the probability of damage caused due to lateral forces.[16]

Performing clinical tooth crown lengthening by the orthodontic method has many advantages, but it is relatively long and expensive, uncomfortable for patient, and surgical treatment is still necessary. This method could be difficult or impossible if there are no adjacent teeth or loss of many teeth. The extrusive process may also cause damage to the pulpal tissue (pulpal necrosis) and can also lead to the ankylosis of the tooth if excessive force is applied.[8]

Although forced eruption is indicated in the anterior region for esthetic reasons, there should be harmony between the esthetics and the periodontal health of the tooth. The mesiodistal diameter of the root, which is naturally "strangled" at the cementoenamel junction of single-rooted teeth, is reduced with progression of the extrusion (especially in the case of conical roots). This involves expansion of interproximal gingival embrasures. The contour shape of the crowns must not be exaggerated to compensate for this reduction in diameter. Similarly, embrasures should not be filled to prevent an overcontour, which could adversely affect the marginal periodontium. In addition, the procedure is contraindicated in multirooted teeth where the furcation is likely to get exposed as a side effect of the procedure.[15,17] Apart from this, forced eruption may also alter the contour of the gingival and osseous margins of the erupting tooth.[18]

Although placement of brackets for the forced eruption of a tooth provides 3D control over the movement of the tooth, a number of other appliance designs and techniques have been tried. Jain et al[19] used a removable appliance (Hawley's appliance with a loop in the labial bow in the region of the tooth to be extruded). In this technique a dowel with a J hook was temporarily cemented in the root canal, and an elastic was engaged between the J hook and the loop on the appliance to exert light extrusive force on the tooth. Bach et al[15] suggested a few more techniques, including the use of a stainless steel wire (0.018 in diameter) shaped into a horizontal loop. A wire in the form of a spiral (a spring) can also be used to provide the necessary traction force. Another strategy consists of inserting a rigid wire into the restorations of the anchor teeth. In this technique, a metal wire, 0.7 mm in diameter, hooked at one end, is cemented into the canal of the tooth to undergo extrusion. Elastic connects the hook to the rigid anchor wire to activate the mechanism. This method can be difficult to use on posterior teeth because occlusion can interfere with the mechanism. If the anchor teeth have not been restored, a rectangular stainless steel arch wire (0.018 or 0.019 in $\times$ 0.025 in) can be folded and affixed with composite to the buccal aspect of each tooth. The extrusive force can be applied by the help of elastic attached to the rectangular stainless steel wire and the dowel cemented in the root canal of the tooth. Alternatively a temporary crown can be fabricated over the dowel and can be used as a traction attachment point. This approach also maintains the esthetics during the long treatment procedure.

Instead of performing orthodontic extrusion and fibrotomy, Calişkan et al[20] suggested surgical repositioning as an alternative modality of treatment for crown root fracture. In this technique a single step, intraalveolar transplantation, extrudes a deep fractured root into a position accessible for restoration. Although orthodontic forced eruption is more time consuming and requires more visits than surgical extrusion, it is a better option, because orthodontic forces allow a biological erupting of the tooth, with no removal of alveolar bone and better final esthetics.[21] Although the procedure was described by Tegsjo et al in 1978,[22] the value of this method on a long-term basis is not yet clear. Recently, Garg et al[23] reported a case in which this technique was used to extrude or reposition an intruded immature permanent incisor. Gungor et al[24] and Filho et al[25] have also found this method to be promising in the management of intrusive luxation. A number of treatment options are available for the management of subgingivally fractured teeth; however, none should be used as rule. Rather, the selection should always be customized to the individual case, and a multidisciplinary approach should always be considered to rehabilitate such cases.

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