Extraction of Maxillary Central Incisors with Short Roots for Orthodontic Treatment of Maxillary Protrusion and Open Bite

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Received 6 March, 2020/Accepted for publication 7 July, 2020
Published Online in J-STAGE 10 November, 2020

Abstract

This case report describes the unusual choice of extraction of maxillary incisors with short roots as part of an orthodontic treatment plan. The patient was a 20-year-old woman referred to our department in whom the diagnosis was maxillary protrusion and open bite. Both of the maxillary central incisors had short roots. Two treatment options were considered. The first involved extraction of the 4 first premolars with the aim of improving dentoalveolar protrusion and crowding. If preservation of the central incisors subsequently became difficult due to root resorption, prosthetic options were to be considered. The second treatment option involved extraction of the maxillary central incisors with short roots and the mandibular first premolars. The second treatment option was selected as survival of the central incisors following orthodontic movement was uncertain and the patient also wanted to minimize the risk of future extractions and the use of prosthetics. Active treatment was performed over a span of 31 months, and circumferential type retainers were used on both arches for retention. For such treatment to be successful, careful diagnosis and orthodontic treatment planning must be taken to ensure the anterior dental esthetics are properly restored.

Key words: Orthodontic treatment — Short root — Root resorption — Central incisor extraction — Orthodontic treatment planning

Introduction

The dentofacial features of a given individual can act as a major contributory factor in the potential severity of dental trauma. The data suggest that patients with proclination of the incisors are at higher risk of trauma to the anterior incisors during childhood than those in whom this condition is absent. Anterior teeth that have been subjected to trauma often grow short roots due to developmental failures. The long-term prognosis for traumatized anterior incisors is unfavorable, with these teeth frequently displaying progressive apical root resorption when orthodontic forces are applied.
Treatment in patients with anterior open bite and incisor proclination usually involves extraction of the premolars with the aim of improving maxillary protrusion and crowding\(^\text{3}\). Moreover, the incisors have to be moved considerably to achieve normal occlusion, which leads to the risk of severe root resorption. Therefore, extraction of the incisors is considered a viable option in orthodontic treatment if the roots of the incisors are short due to trauma.

This case report describes unconventional extraction of maxillary incisors with short roots in the treatment of maxillary protrusion and anterior open bite. For this treatment to be successful, careful planning was required.

Fig. 1  Intraoral and facial photographs at pre-treatment.

Fig. 2  Pre-treatment digital cast models.
to ensure that the anterior dental esthetics were properly restored.

Case Presentation

1. Etiology

A 20-year-old woman was referred to the Department of Orthodontics at Tokyo Dental College with the chief complaint of anterior open bite and protrusion, which affected the patient’s profile. She was referred to our department by her local orthodontist who had discovered that her maxillary central incisors had short roots. The patient’s medical history revealed nothing remarkable. She had experienced trauma to her maxillary central incisors at the age of 8 years when a basketball hit her in the face, however. She did not recall receiving dental treatment after the incident. The local orthodontist was concerned that she might lose her anterior teeth if orthodontic forces were applied. Therefore, she was referred to our facility in order to receive interdisciplinary treatment.

2. Diagnosis

The patient had a convex profile with no facial asymmetry. Intraoral findings revealed overjet of 5 mm, overbite of −5 mm, and an Angle class III molar relation. Both the maxillary and mandibular arches were oval-shaped and, unlike the lateral incisors, the maxillary central incisors showed marked protrusion. The mandibular arch showed minor anterior crowding and a slight curve of Spee. Although, overall, the widths of the maxillary and mandibular anterior teeth were large, at 77.3%, the anterior ratio was in good balance. The patient had the functional habit of tongue-thrusting when speaking. A panoramic radiograph revealed that all 4 of the third molars were present, and that the maxillary third molars were affecting the angulation of the secondary molars. A periapical radiograph showed that the maxillary central incisors had short roots (Figs. 1–3). Lateral cephalometric analysis yielded the following skeletal values: an ANB of 1.2°, facial angle of 82.4°, Y-axis of 67.3°, FMA of 33.8°, and gonial angle of 129.5°. These values indicated a moderate dolichofacial pattern. The maxillary and mandibular incisors values were as follows: a
The maxillary incisors showed severe proclination, yielding an acute nasolabial angle of 89.9° (Fig. 4, Table 1). Based on these findings, the diagnosis was maxillary protrusion with open bite and short bilateral maxillary central incisor roots.

### 3. Treatment objectives

The treatment objectives were to correct the open bite and maxillary protrusion to establish ideal overbite and overjet, thus improving the facial profile. Careful treatment planning was required to achieve these objectives due to the underlying issues associated with the maxillary incisors with short roots. Proper planning was also crucial since the maxillary incisors play an important role in anterior dental esthetics.

| Variable                  | Mean (± SD) | Pre-treatment | Post-treatment |
|---------------------------|-------------|---------------|----------------|
| SNA (deg.)                | 83.2±3.4    | 77.9          | 77.5           |
| SNB (deg.)                | 80.4±3.2    | 76.7          | 76.5           |
| ANB (deg.)                | 2.8±1.8     | 1.2           | 1.0            |
| Facial angle (deg.)       | 85.9±1.7    | 82.4          | 82.3           |
| Y-axis (deg.)             | 64.3±2.3    | 67.3          | 67.2           |
| FMA (deg.)                | 26.4±3.8    | 33.8          | 34.0           |
| Gonial Angle (deg.)       | 120.2±4.0   | 129.5         | 129.2          |
| Occ. Plane to FH (deg.)   | 8.6±5.6     | 12.4          | 11.4           |
| U1 to FH (deg.)           | 115.2±5.9   | 131.9         | 105.0          |
| IMPA (deg.)               | 98.2±4.1    | 95.6          | 80.0           |
| FMIA (deg.)               | 58±6.7      | 50.6          | 66.2           |
| Interincisal (deg.)       | 121.9±3.7   | 98.7          | 141.1          |
| Nasolabial Angle (deg.)   | 105±6.0     | 89.9          | 100.1          |
| E-line: Lower (mm)        | 2.0±2.0     | 1.1           | −3.2           |
| Overjet (mm)              | 2.9±0.8     | 5.5           | 3.1            |
| Overbite (mm)             | 3.1±1.1     | −5.3          | 2.0            |
4. Treatment alternatives

Two treatment options were considered to approach these objectives. The first treatment option was to take the conventional approach and extract all 4 premolars to improve dentoalveolar protrusion and anterior crowding. However, the prognosis with this approach suggested that the maxillary central incisors would be compromised if apical root resorption occurred as a result of orthodontic tooth movement. If preservation of the central incisors became difficult, prosthetic options such as fixed partial dentures and dental implants were to be considered. The second treatment option was to extract the maxillary central incisors with short roots and the mandibular
first premolars. With this approach, the maxillary lateral incisors could be moved mesially into the positions previously occupied by the central incisors. Resin-composite or ceramic restoration could then be used on the lateral incisors to provide the features of central incisors.

The second treatment option was finally selected due to the significant horizontal displacement of the central incisors and the uncertainty regarding the survival of the central incisors following orthodontic movement. The patient also requested a treatment method which involved the least possibility of extraction and need for prosthetic procedures at a future date.

Clinical Procedures and Outcomes

1. Treatment progress

Before orthodontic appliances were attached, the patient was given specific instructions on maintenance of oral hygiene and myofunctional training, which included button-pull exercises to promote lip-sealing and tongue exercises to prevent tongue-thrusts. The dental hygienist explained the importance of maintaining good oral hygiene and oral function, and emphasized how these
should be carried throughout treatment and retention.

For anchorage control and molar uprighting to treat the anterior vertical discrepancy, a transpalatal arch was attached to the maxillary arch, a lingual arch was attached to the mandibular arch, and all of the third molars were extracted at the beginning of treatment. The mandibular first premolars were then extracted and pre-adjusted 0.022×0.028-inch self-ligating brackets placed. Sequential leveling and aligning were performed using 0.014-, 0.016-, 0.016×0.022-, 0.017×0.025-, and 0.019×0.025-inch heat-activated nickel titanium arch wires; a 0.019×0.025-inch stainless steel arch wire was used for space closure by means of intermaxillary elastic chains. Extraction was initially planned for
the bilateral maxillary central incisors at 8 months after commencement of active treatment. This was postponed, however, as the patient requested the procedure to be performed after she had finished attending job interviews. Anterior space closure in the mandibular arch was initiated at 11 months, therefore, and the maxillary central incisors extracted at 14 months. Prosthetic teeth were temporarily attached to the wires at the extraction sites (Figs. 5, 6). The distal proximal surfaces of the prosthetic teeth showed a gradual reduction as the space closed. The lateral incisors were temporarily shaped into central incisors using composite resin. A set of 0.017×0.025 beta titanium arch wires and vertical elastics were used in the detailing stage. Gingival hyperplasia developing in the interdental papilla region between the extracted maxillary central incisors was treated with a gingivectomy following orthodontic treatment. The lateral incisors were restored using ceramic crowns. The active treatment period was a total of 31 months. At the end of active treatment, circumferential type retainers were made for both arches to promote retention.

2. Treatment results

The reduction in lip protrusion and large improvement in the nasolabial angle, from 89.9° to 100.1°, resulted in favorable changes in the facial profile. A significant improvement was also observed in the smile arc. Intraoral findings revealed a Class I molar relation with normal overjet and overbite, indicating proper alignment of the dental arches. The anterior ratio was 75.7%, demonstrating positive anterior balance. Post-treatment panoramic and periapical radiographs showed that the roots were almost parallel with the healthy supporting tissues. They also revealed that the roots of the lateral incisors were slightly blunted, however (Figs. 7–9). The post-treatment cephalometric analysis and superimposed tracing showed no change in skeletal variables. The imagery revealed considerable change in position of both the maxillary and mandible incisors. The U1-to-FH value changed from 131.9° to 105.0°, the IMPA from 95.6° to 80.0°, and the FMIA from 50.6° to 66.2°. These changes helped improve lip competence and the nasolabial angle (Figs. 10, 11 and Table 1). Successful gingivectomy was performed in the upper labial frenulum region, and the maxillary lateral incisors were transformed into the central incisors with ceramic crowns (Fig. 12). The patient was satisfied with the results.

Discussion

Premolar extraction is the conventional option in orthodontic treatment in patients with anterior open bite and incisor proclination with no skeletal discrepancies. In the present case, the patient had experienced trauma to the maxillary central incisors at the age of 8 years. At that age, the tooth roots are still in the developmental stage, so the trauma that she experienced likely explains why the incisors had developed short roots. When developing the treatment plan, the main concern was the condition of the protruded maxillary incisors. Studies have shown it is possible to preserve teeth with short roots when the teeth are moved in intervals and the total treatment time is short\(^9,14\). If a large amount of movement is required, however, application of such orthodontic forces takes a long time, which is not recommended, as this may lead to progressive apical root resorption\(^2\). The data show that there is an elevated risk of apical root resorption in teeth with abnormal root shapes and horizontal root displacement, and in patients who have a tendency to perform tongue-thrusting\(^10\). Both of the present patient’s central incisors exhibited structural characteristics associated with these risk factors, that is, short roots and incisor proclination. In addition to these risks, the patient had the oral habit of tongue-thrusting when speaking. Thus, it was believed that applying orthodontic forces would increase the risk of losing both the maxillary incisors in the future. Interdisciplinary management of the extraction space with prosthetic restorations,
such as fixed partial dentures or dental implants, is a viable treatment option and has been utilized in the past\(^6,12\). In the present case, treating the anterior open bite by extracting all 4 first premolars would have improved the facial profile and open bite. However, this treatment method may have led to the loss of the maxillary central incisors, with the patient then losing a total of 6 teeth. Evaluation of the patient’s dental condition and the associated risk factors of both treatment options indicated that extraction of the maxillary central incisors was the appropriate orthodontic treatment plan.

The maxillary central incisor plays an important role in the esthetics of the anterior teeth. Thus, meticulous treatment planning must occur before the extraction procedure\(^4,5,16\). Following extraction, prosthetic teeth were attached to orthodontic wires to fill the extraction space, which was gradually reduced. The mean width of the maxillary central incisors, lateral incisors, canines, and first premolars was 9.1 mm, 7.15 mm, 8.2 mm, and 7.4 mm, respectively. These crown widths were used to calculate the anterior ratio to achieve optimal overjet and overbite at the end of orthodontic treatment. Approximately 2 mm of resin composite was added to the lateral incisors to simulate the width of the central incisors. The canines eventually shifted to the sites previously occupied by the lateral incisors. This resulted in the canine’s bell-shaped distal contact point surfaces requiring proximal reduction and the cusp tips needing contouring. The labial-lingual width of the maxillary canines is usually larger than that of the lateral incisors. Therefore, the canines needed to be flattened. Long-term clinical and radiograph evaluations have shown that a substantial amount of dental grinding may be performed with only temporary reactions\(^13\). The canine features were not prominent in the present patient, and she requested grinding to be kept to a minimum. Therefore, the tip of the cusp was reduced by only 1 mm. The canine roots also required palatal displacement to simulate the lateral incisors while ensuring that the roots remained within the alveolar bone housing. The first premolars play a significant role in anterior dental esthetics, specifically with their movement into the canine position. Mesial rotation of the crown to conceal the mesial proximal surface for esthetics and buccal root torque should be added so that the lingual cusp does not interfere with lateral occlusal movement. In this case, the canines are substituted for the lateral incisors, so mutually protected occlusion can not be achieved. Studies have shown, however, that group function occlusion was equally acceptable\(^15\). Although post-treatment radiographs showed that the lateral incisors roots were slight blunted in the present case, they also showed that the supporting tissues around the roots were healthy. Periapical radiographs will be taken during retention to evaluate the root conditions. Ceramic crown adjustments will be made if required to adjust occlusal loading. When the central incisors are chosen to be extracted due to short roots, careful diagnosis and orthodontic treatment planning must be taken to ensure that anterior dental esthetics are properly restored.

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