Substitution of Maxillary Central Incisor with Forced Eruption of Impacted Maxillary Canine

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Keywords
Transposed and impacted upper canine; Forced eruption; Collapsed anterior alveolus; Dilacerated central incisor.

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CASE REPORT

Substitution of Maxillary Central Incisor with Forced Eruption of Impacted Maxillary Canine

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ABSTRACT

This case report describes the orthodontic management of missing teeth and rehabilitation needs in a 26-year-old woman. Several missing teeth on her maxillary anterior esthetic zone, a poor prognosed left mandibular first molar and a missing right mandibular first molar was also found. The treatment plan included extraction of the unrestorable maxillary left incisor, surgical exposure and forced eruption of the impacted maxillary left canine. While on the lower arch, protraction of mandibular second and third molars was planned. A good functional occlusion was achieved after 42 months treatment duration. The transposed impacted maxillary left canine was orthodontically extruded and successfully replaced the maxillary left incisor, and extraction space of the mandibular first molar was closed. Taiwanese Journal of Orthodontics 2023;35(3):136–146

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INTRODUCTION

Forced eruption, also called orthodontic extrusion,1,2 is defined as orthodontic movement in the coronal direction via a light continuous force to induce a volumetric change in the alveolar bone and soft tissue. By erupting an impacted tooth with a negative osseous profile, the interproximal bone is manipulated thereby creating an osseous peak that will stimulate and support the corresponding soft tissue. This technique was applied in this case report where an impacted canine was found in the ectopic position of an incisor and excellent result was yielded.

CASE REPORT

Clinical examination

Multiple missing teeth and rehabilitation of extraction space were the main concern of this patient. Mild facial asymmetry was noted in the facial photographs (Figure 1). Skeletal component of the patient was close to normal except the maxilla was slightly retrusive in proportion. The maxillary right central incisor was found rotated and right canine was in high position from the occlusal line. The upper left canine was impacted.

Patient’s dental occlusion fell into Angle’s Class III. Bilateral primary canines were retained in the maxillary dentition, whereas maxillary left incisor and canine were nowhere to be seen. A collapsed alveolar ridge was noted at front (Figure 2). Angle’s Class I molar on the left side due to mesial drift of the maxillary first molar was illustrated (Figure 3).

Only mild crowding was found on the mandibular arch (Figures 2–4). There was a missing right first molar and left first molar with large restoration. By taking occlusal, periapical, and panoramic x-ray film, impacted maxillary left incisor and canine with severe crowding were revealed.

The impacted maxillary left canine was transposed with the maxillary left lateral incisor. It (23)
had a good prognosis in terms of angulation, root form and length (Figure 4). On the other hand, radiolucency was noted on apical region and furcation area of mandibular left first molar, tooth crack was highly suspected, rendering it hopeless. Cone-beam computed tomography (CBCT) examination provided an anatomical detail of the impacted canine along with its labiolingual relationship with the roots of neighboring teeth (Figure 5).

Lateral cephalometric analysis revealed the ANB angle was 1° (SNA angle:82°, SNB angle:81°) and the mandibular plane angle was 36° which was above normal average. The maxillary incisor was normally angulated while the mandibular incisors were lingually inclined (Figure 6).

**Diagnosis**

1. Straight facial profile with mild maxillary retrusion and mild facial asymmetry.
2. Dental Class II relation with severe maxillary crowding.
3. 13 complete labial blockout; 21 impaction and dilaceration; 22, 23 transposition and 23 impaction; retained 63.
4. 36 tooth fracture, 46 missing, 38, 48 mesial angular impactions.

**Treatment plan**

As facial asymmetry was of no concern to the patient, thus pure orthodontic treatment was given. The treatment plan for multiple missing teeth has different options relying on the facial profile of the patient and the intraoral condition of the teeth. Options include space regain for prosthesis rehabilitation, space closure or replacement with adjacent tooth. In this case, the impacted canine was transposed with the maxillary left lateral incisor. It had a good prognosis in terms of angulation, root form and length. Force eruption was feasible to replace the missing incisor without jeopardizing the profile of the patient.

Primary canines and mandibular left first molar were removed followed by surgical exposure at upper incisor region (Figure 7). The malformed maxillary left incisor was removed. The transposed canine would be guided through orthodontic extrusion procedures (Figure 8). This treatment modality allows us to direct the tooth to the designated position, it also simultaneously stimulates alveolar bone apposition without the use of bone graft or other alternatives.
increased bony and soft tissue volume formed autogenously would have that natural look which is very important in esthetic zone. The risk of root resorption would also largely decrease.3

For management of the mandibular dentition, the left first molar would be extracted. Lower third molars would be uprighted, followed by closure of the extraction space through molar protraction. No use of TADs was required.

Treatment progress

A pre-adjusted 0.022 slot straight wire system was used. On the 15th month, adequate space was created using NiTi coil spring (Figure 9A). Surgical exposure of the impacted canine through and
removal of impacted incisor were conducted. Closed eruption was employed as the impacted canine was way above the mucogingival junction with insufficient attached gingiva (Figure 10) and an elastic power chain to the hook were applied.

On the 18th month, when the canine was near mucogingival junction, an apically positioned flap was then performed to provide clearer vision (Figure 11). Over the next few months, the maxillary canine had successfully reached the occlusal plane while on the mandibular arch, space closure continued (Figure 12). On the 24th month, incisor bracket was bonded on the canine to express the built-in prescription to mimic the inclination and angulation of a regular incisor. Double wire technique was employed (Figure 13).

On the 33rd month, maxillary archwire was changed to 0.018 × 0.025 NeoSentalloy when the canine could be fully engaged. On the mandibular arch, brackets were bonded on third molars and the 0.016 × 0.022 NiTi was used (Figure 14). Treatment progress was further shown in Figure 15.

Treatment results

The treatment duration was 42 months. Removable Hawley retainers were delivered upon bracket debonding. A more harmonious smile and profile at finishing was noted (Figure 16). After debonding, maxillary left canine was reshaped with resin buildup. Post treatment records were taken (Figures 17–19). Lateral cephalogram was analyzed and the data listed at Table 1.
Superimpositions of the cephalograms and occlusograms of pre-treatment and post-treatment were presented in Figures 20 and 21 respectively. Two years follow-up records were shown in Figure 22.

DISCUSSION

In this case, slow traction of the impacted, transposed upper canine mimics the natural eruption process to gain bone apposition through moving the tooth towards the defect site. This was the essence of adult orthodontics. The increased alveolar bone volume not only provides bone housing, but it also delivers a more esthetic outcome.1–3 This strategic approach also results in an increase of both hard and soft tissues of the periodontium.4,5

When orthodontic force was applied, the periodontal ligament fibers (PDL) around the root were stretched causing the pressure side of alveolar bone to resorb. On the tension side, the elongated PDL triggered osteoblastic activity to induce bone formation.6 In our case where the maxillary anterior teeth were involved, the already deficient alveolar ridge and papilla might be worsen following the extraction of the hopeless impacted incisor, further

Figure 10. A, During the 15th month, upper left incisor and canine were surgically exposed. Upper left incisor was extracted and root dilaceration was as expected. B, After extraction of upper left incisor, upper left canine could be more clearly seen. Button was attached on the lingual side of the impacted canine. C and D, A hook was tied, and close method was conducted with the flap sutured back. Elastomeric chain was applied from hook to main arch wire. The main arch wire was 0.17 × 0.25 stainless steel to counter the intrusive force imposed by the impacted canine. Step down bend was performed on upper left anterior area to provide greater distance for greater moment.

Figure 11. A, During the 18th month, upper left canine was again surgically exposed when it could be palpated. B and C, Apically positioned flap was performed and elastic chain was applied from another button attached on the buccal side of the canine to the main wire.

Figure 12. A, B, C, During the 23rd month, the impacted canine was near the occlusal plane. Although rigid stainless-steel wires were applied on both arches, the overbite inevitably became shallower due to the intrusive force resulted from force erupting the impacted tooth. D, E, Both arches were well prepared into ovoid arch form. On the lower arch, space closure continued.
jeopardizing the esthetics. As the impacted canine was forced erupted towards oral cavity, the gingiva and the bone attached by the PDL migrate in the same direction, resulting in a bone deposition at the base of the defect and an augmentation of soft tissue.

For soft tissue augmentation using connective tissue or free gingival graft, surgery is needed. Bleeding, swelling, graft failure, dehiscence, and the discomfort are the possible complication.7,8 Scar could also be formed which is detrimental in esthetic zone.

For hard tissue reconstruction using guided bone regeneration,9 surgery is also needed and it bears the same complication as the soft tissue augmentation.

Served as a non-surgical procedure, orthodontic forced eruption acted as an excellent treatment option because bone is generated from the attachment apparatus of the host without the use of bone graft and had better quality due to osteocytes in the bone lacunae of living cells.10 The increased level of the interproximal bone when tooth is forced erupted provided a more natural presence of post prosthetic papilla.11

The forced erupted tooth gains better results than dental implant as it has the support of PDL to disperse the force of biting and protect the tooth, while implant does not have PDL and its condition is subject to the degree of osseointegration.12

Timing and choice of tooth are also critical. For the timing, sufficient space of the designated position should be gained before force eruption was launched. Good root form and sufficient length, the position of impacted tooth, and whether it could be successfully utilized as a useful tooth for replacement were key factors when assessing choice of tooth for force eruption. Teeth with periapical lesions, severe buccal bone resorption, ankylosis, circumferential and angular defects are contraindicated for orthodontic extrusion.13

Two techniques were employed in this case for the force eruption, namely closed eruption and apically positioned flap technique (Figures 10–12). The periodontal results of these two techniques showed no significant differences in gingival index, pocket depth or bone level. However, esthetic differences were found.15 With an apically positioned
flap, the crown length of the uncovered tooth is longer due to apical migration of the gingival margin. However, with closed eruption, the crown length of uncovered tooth was similar to adjacent teeth. In terms of high labial impactions, tooth uncovered using apically positioned flap tend to re-intrude as mucosal attachment tends to pull the crown of the tooth apically during healing. This disadvantage was not found in closed method cases.

In our case, although closed methods bared the above-mentioned benefits and did not require additional surgery, apically positioned flap was
applied when the maxillary left canine was near the mucogingival junction due to two reasons. One main reason was to provide clearer vision for designing the eruption pathway. Another was to remove the soft tissue obstacles to facilitate the eruption process while simultaneously gained attached gingiva through positioned it apically.

Choice of wires matters. Round wire is favored as it delivers lighter force to direct new bone formation but it has poor control of root movement which is detrimental to the esthetics of the anterior maxilla. Dehiscence or root fenestration is likely to occur. On the contrary, rectangular wire provides better root torque control. However, the generated root torque during extruding may act as a stronger anchorage that causes intrusion of neighboring teeth thus increases risk of root resorption.

Double wire technique is an approach to use a smaller-sized flexible archwire to engage the malaligned tooth while stabilizing the rest of the abutment teeth through use of a larger-sized rigid archwire to prevent undesired tooth movements of the abutment teeth. In the 24th month, 0.14NiTi wire was used to facilitate alignment of maxillary left canine while 0.17 × 0.25 stainless steel wire was used to consolidate the upper abutment teeth (Figure 13). Once the occlusal height was reached, rectangular wire was used to provided proper root torque.

Considerations and managements for tooth substitution

Careful correction of the crown torque of a mesially relocated canine to mirror the optimal lateral incisor crown torque, along with the provision of optimal torque and rotation for the mesially moved maxillary first and second premolars.

- Esthetic recontouring of a mesially relocated canine to a more ideal lateral incisor shape and size by grinding and composite resin buildups or porcelain veneers.
- Intentional vital bleaching of a yellowish canine that has been moved mesially into the lateral incisor position.
- Individualized extrusion and intrusion during the mesial movement of the canine and first premolar, respectively, to obtain an optimal level for the marginal gingival contours of the anterior teeth.
- Increasing the width and length of mesially moved and intruded first premolars with composite resin buildups and/or porcelain veneers.
Simple minor surgical procedures for localized clinical crown lengthening for replacing central incisor with canine, palatal crown torque should be applied to the canine. Esthetic recontouring of canine was needed by grinding the tip, mesio-incisal, disto-incisal, labial, and lingual side of a canine to mimic an incisor, followed by intentional vital bleaching of a yellowish canine before composite resin buildups or porcelain veneers.

For replacing canine with first premolar, optimal torque should also be applied along with mesial rotation of first premolar to mimic the form and contour of a canine upon smiling. Occlusal adjustment should be performed on the lingual cusp of first premolar to eliminate any interference upon lateral excursive movement. Enameloplasty and resin buildup are also suggested. Intrusion of first premolar was recommended to obtain an optimal gingiva level.

Upon finishing, gingival contours and gingiva level of the anterior teeth should be monitored through minor surgical procedure such as clinical crown lengthening for optimal results.

**Atherton’s patch**

The most difficult endeavor in anterior intervention is the papilla regeneration.

In Figure 16, Atherton’s patch was recognized. This bright red non-keratinized epithelial patch is noticed after tooth extrusion. It is due to coronal displacement of the attached fiber bundles, causing pocket wall to evert during. It will keratinize in 28 days–42 days and will develop as the emergence profile for the tooth. A raise in the interdental bone height and papilla height are unique advantages of forced eruption that cannot be achieved by regenerative surgery.
Molar protraction

Missing first mandibular molar led to tipping and drifting of adjacent teeth. One treatment option would be space regain for prostheses. Another option would be space closure. Mandibular second molar protraction was feasible yet difficult due to larger amount of cortical bone and the powerful musculature in the posterior region of the mandible compared to maxilla. Difficulty increased in cases with atrophied edentulous sites, and in adult cases.

In adult cases where the patient’s profile is straight and remaining space is found, molar protraction will be suggested. The advantages of molar protraction were consuming remaining space without jeopardizing the already optimal profile. It also bears the advantages of increasing alveolar ridge thickness during space closure with molar protraction.

Protraction using skeletal anchorage of temporary anchorage devices (TADs) is inevitably a better option in this case. In this case, after enough space was used to relieve crowding and to retraction, protraction using TADs was suggested yet the patient still considered her upper incisors to be too proclined, therefore minimal anchorage was designed to facilitate molar protraction along with mild retraction of lower incisors.

The mechanics of protracting mandibular molars involve counteracting the effect of extrusion and mesial tilting during protraction. A tip back and step-down bend was made on NiTi rectangular wire and later changed to rigid rectangular stainless-steel wire facilitate the uprighting and protraction process.

Glass ionomer was applied on the lingual cusp of upper first premolar and upper second molars for better disocclusion during molar protraction. As minimal anchorage was designed on the lower arch, lower teeth are tied to form a better anchorage to protract lower second molars. After lower second molars are protracted, lower second molars are tied with lower teeth to form a stronger anchorage unit for third molar protraction.

In our case, as mandible third molars were uprighted and protracted, the PDL fibers were stretched, new alveolar bone was gained at the tension sides which are the mesial surface of the third molars and the distal surface of second molar. The alveolar crest level of this intermolar region improved during molar uprighting (Figure 18).

CONCLUSION

In this case, maxillary impacted canine was successfully guided coronally, bringing up an extra fresh bone and soft tissue which helped warrant a steady occlusion and esthetic enhancement.
The orthodontic extrusion technique should be slow, non-invasive. As long as the PDL was healthy, the maxillary anterior teeth could have enough rejuvenated alveolar bone and gingival tissue to cope with any orthodontic mechanotherapy. Advanced periodontal surgery was therefore avoided.

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ETHICAL APPROVAL

Not required.

PATIENT CONSENT

Provided.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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