Successful Orthodontic Treatment of Bimaxillary Protrusion Case with an Ankylosed Incisor—A Case Report and Decision-Making Process

Shu-Cheng Lin
Section of Orthodontics, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan

Szu-Ching Lee
Section of Orthodontics, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan

Yi-Ching Ho
School of Dentistry, National Yang-Ming Chiao-Tung University, Taiwan

Kai-Hsiang Chuang
Section of Orthodontics, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan

Tzu-Ying Wu
Section of Orthodontics, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan

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Keywords
Dental ankylosis; Ankylosed incisor; Bimaxillary protrusion; Decoronation; Replacement root resorption

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Author #1
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CASE REPORT

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Shu-Cheng Lin a, Szu-Ching Lee a, Yi-Ching Ho a,b, Kai-Hsiang Chuang a, Tzu-Ying Wu a,b,*

a Section of Orthodontics, Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan
b School of Dentistry, National Yang-Ming Chiao-Tung University, Taiwan

ABSTRACT

The treatment of ankylosed incisor is challenging for orthodontists, necessitating accurate diagnosis, well-considered treatment planning, and close collaboration among interdisciplinary teams to achieve favorable esthetic and periodontal outcomes. For ankylosed cases, accurate diagnosis depends on detailed clinical examination and 3D radiographic images. This case report described the treatment of a bimaxillary protrusive female with an ankylosed maxillary left central incisor. The decision regarding treatment was based on the severity of dental ankylosis and replacement root resorption. Each treatment plan comes with its own set of advantages and disadvantages. In this case, the decoronation treatment plan and prosthesis was implemented, resulting in favorable anterior esthetics. The protrusive profile significantly improved, after anterior teeth retraction successfully. Detailed progress and discussions will be illustrated in this case report. Taiwanese Journal of Orthodontics 2023;35(4):192–201

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INTRODUCTION

Dental ankylosis refers to lack of mobility of a tooth which caused by the direct contact between root surface and surrounding alveolar bone.1 It usually related to injury of the periodontal ligament (PDL) and the degradation of PDL cells. The most common etiology of the dental ankylosis was dental trauma, particularly avulsion.2–4 Avulsion results in severe damage of PDL tissue and pulp tissue of the traumatized tooth after repositioning. Immediately after replantation, the inflammatory response takes place. During the healing progress, bone grew into PDL space faster than the fibroblasts and cementoblasts, leading to the fusion of the dental root with the alveolar bone.1,5 Dental ankylosis can have several consequences, including infraocclusion, supra-eruption of antagonists, tilting of the adjacent teeth, loss of alveolar bone and ectopic eruption of successor.4 The incidence of dental ankylosis in primary dentition has been reported to range from 1.5 % to 9.9 % according to various studies.3,6,7 In permanent dentition, the incidence is approximately one-tenth of that observed in primary dentition. Dental ankylosis most commonly affects first molars, primarily as a result of orthodontic force application on teeth experiencing primary eruption failure. In adolescents, maxillary incisors are at a higher risk of dental trauma, making ankylosis in these teeth occasionally encountered. Infraocclusion of the ankylosed incisors, occurring after passive eruption of adjacent teeth, can significantly impact anterior aesthetics. Since ankylosed teeth are difficult to move with orthodontic force, it presents a significant challenge to orthodontists to solve the esthetic problem caused by ankylosis of the maxillary incisor.

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* Address correspondence to Dr. Tzu-Ying Wu: No. 201, Sec. 2, Shipai Rd., Beitou District, Taipei City, 11217, Taiwan. Fax: +886 2 28742375.
E-mail address: wu_3793@yahoo.com.tw (T.-Y. Wu).

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CASE REPORT

Clinical examination

The patient was a 38-year-old Taiwanese female with a chief complaint of protrusive lips and uneven gum line. This is a case with dentophobia, who resisted most invasive dental procedure at beginning. She did not have any history of systemic disease and denied history of dental trauma. From extraoral examination, the patient had perioral protrusion, lip incompetence and mentalis strain at rest (Figure 1). Her upper dental midline was coincided with the facial midline, and lower dental midline was deviated 2 mm to her left side. Intraorally, she had Class I molar relationship, and there was deep probing over upper anterior region and severe gingival recession over lower anterior teeth at lingual side. An uneven level of the two maxillary central incisors was apparent, which was one of her main concerns (Figure 2). The maxillary left central incisor was in a higher position, and with metallic sound during percussion test. The periapical film of the tooth 21 showed discontinued PDL with an abnormal shadow at the middle third of the root (Figure 3A). Therefore, cone-beam computed tomography (CBCT) examination was necessary. The sagittal sectional view demonstrated that a wide range of root resorption was originated externally and extended into canal (Figure 3B). The pre-treatment panoramic film also showed deep caries over tooth 25. As shown in the Table 1, the lateral cephalometric analysis indicated that the patient was a Class I normal angle case with bimaxillary dental protrusion.

Diagnosis

According to the above data, the patient was diagnosed as a Class I bimaxillary protrusion case with an ankylosed upper left central incisor.

Treatment objectives

The treatment objectives were as follows: (1) improve the protrusion of lips; (2) correct the proclination and protrusion of the incisors; and (3) manage the ankylosed incisor, correct the uneven gum line and level of maxillary central incisors.

Treatment plan and alternatives

The treatment plan for this bimaxillary protrusion case was to extract four first premolars. However, due to deep caries, upper 2nd premolars were decided to be remove and screw anchorage was used to optimize the maxillary anterior teeth retraction. As for the ankylosed incisor, we had four treatment options as follow. (1) orthodontic retraction after surgical subluxation; (2) setback the whole maxillary anterior segmental by osteotomy with the ankylosed incisor; (3) remove the ankylosed teeth and restore with prosthesis after orthodontic treatment; (4) decoronation of the ankylosed teeth during treatment to preserve bone and restore with...
prosthesis after orthodontic treatment. After pros and cons of each procedure explained in detail to the patient, the patient chose the decoronation treatment option (Table 2).

**Treatment progress**

Before orthodontic treatment, the patient received phase I periodontal treatment and underwent a soft tissue graft on the lower anterior lingual side by a periodontist (Figure 4). After the periodontal condition was under controlled, upper arch was bonded with 0.022 X 0.028 pre-adjusted edgewise brackets, while the ankylosed incisor was bypassed. Sequential leveling and alignment procedures were then performed. In the lower arch, the first premolars were extracted, and the canines were retracted with sectional loop mechanics. After 3 months of treatment, bilateral IZC screws were placed as anchorage of anterior retraction and posterior active vertical control following extraction of upper second premolars (0.016 x 0.022 SSW). The lower arch was fully bonded and aligned from the 8th month. After 8 months of upper anterior teeth retraction, a deepened overbite with anterior teeth dumping was observed, except for tooth 21. Therefore, the ankylosed tooth (tooth 21) was utilized as absolute anchorage to level the adjacent incisors by placing bracket at higher position (Figure 5). After 19 months of treatment, the deepened overbite was corrected, and a 0.016x0.022 SSW was placed including the ankylosed teeth to maintain the vertical position of adjacent anterior teeth. By the 23rd month, the extraction space was nearly closed, but the ankylosed incisor remained in a relatively forward position, leading to an unesthetic appearance (Figure 6A). At that point, it was decided to perform the decoronation procedure before final prosthesis placement. The patient was referred to the endodontist for pulp extirpation first. The pulp tissue was meticulously removed using sterile dental files, and the area was thoroughly rinsed with saline solution until bleeding was induced from the surrounding tissues into the canals. Following that, the coronal portion was separated by approximately 2 mm below the bone margin without the need for flap elevation or suturing (Figure 6B). Subsequently, the cervical portion of the crown was reshaped, and the pulp chamber was restored with composite resin. Within 1 h after decoronation, the preserved crown was fixed onto the main archwire through a bracket in a well aligned position for esthetics during the final stage of orthodontic treatment (Figure 6C). Following the surgery, the patient was instructed to maintain oral hygiene by using dental floss under the pontic crown. This was crucial for ensuring a clean environment over the surgical area and facilitating optimal soft tissue healing over the decoronation region. After four months, the remaining root was underneath and covered by keratinized gingiva (Figure 6D). Finally, the patient was debonded when occlusion was properly settled, and the prosthesis was delivered at the 36th month. Vacuum-formed retainers and Hawley retainers were also provided to ensure long-term stability and retention of the achieved results.

*Figure 2. Pre-treatment intraoral photos. An uneven level of upper central incisors was apparent. The overjet and overbite were 4 mm and 2.5 mm on her right side but 2 mm and 1.5 mm on her left side.*
Treatment results

The final records showed an improved of protrusive profile. The prosthesis was designed as a cantilever by prosthodontist on the upper central incisors (Figure 7). The occlusion was stable with a molar Class I relationship. The root of ankylosed incisor still existed in the panoramic film. In the lateral cephalometric analysis (Figure 8, Table 1), the upper and lower incisors were retracted without extrusion, and the upper and lower lips moved backward. The mandibular plane angle decreased and resulted chin forward movement (Figure 9).

DISCUSSION

The management of an ankylosed tooth is a challenge for orthodontists. The initial diagnosis can be complicated, and it may require several examinations before reaching confirmation. Gathering a comprehensive dental trauma history from both the patient and parents are essential. During clinical examination, the presence of an infra-occluded tooth without an apparent etiology may serve as an indicator of ankylosis. According to Andersson’s findings, if the affected root surface exceeds 20 %, a metallic sound is produced upon percussion, and the tooth exhibits a lack of mobility during clinical manipulation. However, the reliability of the percussion test diminishes when the ankylosed root surface is limited. Ankylosis sites may exhibit obliteration of the periodontal ligament (PDL) space and irregularity of root surface in periapical radiographs and CBCT scans. Becktor proposed that vertical bone loss and a curved root appearance in radiographic images provide valuable diagnostic clue. The definitive diagnosis could be confirmed after application of diagnostic orthodontic force on the tooth. However, there might arise side effects on anchorage tooth in this procedure. In our case, the diagnosis was substantiated by the presence of a metallic sound during the percussion test and evident replacement root resorption observed in the CBCT scans.

Table 1. Pre-treatment and post-treatment cephalometric values.

<table>
<thead>
<tr>
<th></th>
<th>Norm</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skeletal analysis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNA(°)</td>
<td>79.72–86.1</td>
<td>82</td>
<td>81.5</td>
</tr>
<tr>
<td>SNB(°)</td>
<td>79.72–83.7</td>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>ANB(°)</td>
<td>0.7–3.8</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>SN-MP (Go-Gn) (°)</td>
<td>25.52–34.48</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td><strong>Dental analysis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 TO NA (mm)</td>
<td>3.18–7.34</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>1 TO SN(°)</td>
<td>102.23–115.13</td>
<td>113</td>
<td>101</td>
</tr>
<tr>
<td>1 TO NB(mm)</td>
<td>3.18–7.34</td>
<td>11.5</td>
<td>5.5</td>
</tr>
<tr>
<td>1 TO MP(°)</td>
<td>90.56–103.12</td>
<td>103.5</td>
<td>96</td>
</tr>
<tr>
<td><strong>Profile analysis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper-E line (mm)</td>
<td>–2.93–0.41</td>
<td>1</td>
<td>–2</td>
</tr>
<tr>
<td>Lower-E line (mm)</td>
<td>–1.86–2.1</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
In this case, the orthodontist had various treatment options to recover anterior aesthetics and retract the protrusive lips, thereby improving the overall facial profile. Indeed, each treatment plan comes with its advantages and disadvantages that need to be carefully evaluated. Additionally, the patient's concern plays a significant role in influencing the final treatment decision.

### Table 2. Treatment option of ankylosed incisor.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 2</td>
<td>Anterior osteotomy to setback the whole anterior maxilla segment.</td>
<td>Keep the nature tooth.</td>
<td>The most aggressive procedure. Highest cost. Risk of injury to the teeth near the cutting line. May leave an unknow prognostic tooth.</td>
</tr>
<tr>
<td>Option 3</td>
<td>Extract the ankylosed tooth and restore with implant or bridge.</td>
<td>Remove the unknow prognosis tooth.</td>
<td>Large bony destruction after surgical extraction of the ankylosed tooth. Risk of losing the alveolar bone volume. Necessary of prosthesis to recover the esthetics.</td>
</tr>
<tr>
<td>Option 4</td>
<td>Decoronation the ankylosed incisor and restore with bridge.</td>
<td>Non-invasive procedure. Preserve the alveolar bone volume.</td>
<td>Necessary of prosthesis to recover the esthetics. May leave an unknow prognostic root fragment.</td>
</tr>
</tbody>
</table>

Surgical luxation is a commonly employed method to disrupt the connection between the ankylosed tooth and the surrounding alveolar bone, allowing for moving the tooth. However, it should be noted that surgical luxation carries the risk of re-ankylosis during subsequent orthodontic procedures and is only indicated in the cases of spot ankylosis. In the case with extensive root resorption, the success rate of surgical luxation is especially low, and there is an increasing risk of root fracture during the surgical intervention. Therefore, surgical luxation may not be a viable solution in such cases.

Osteotomy, as a treatment approach, involves moving the ankylosed tooth along with the surrounding bone, as the replacement resorption root cannot be separated with the alveolar bone. The single tooth osteotomy is typically a preferred approach. However, in this case, an anterior osteotomy of the maxilla after extracting the upper premolars could allow for the simultaneous retraction of all anterior teeth and improving the protrusive profile.

Nevertheless, it is important to consider that this procedure is more aggressive and carries the risk of root damage and periodontal loss. Additionally, there is a possibility of leaving an unknown prognostic ankylosed tooth, which could potentially lead to further complications in the future. Moreover, this approach also increases the overall cost for the patient. Considering the patient's dentophobia and she refused to undergo any aggressive procedures, particularly orthognathic surgery, alternative treatment options must be explored.

Extraction is the definitive method to address ankylosed teeth conclusively. However, extracting...
an ankylosed tooth is a complicated process and often needs to remove a certain amount of surrounding bone. As a consequence, it may compromise the volume and height of the alveolar bone, which could potentially jeopardize the feasibility of implant prosthesis or affect the esthetics of a pontic in bridge prosthesis.\footnote{12} In our case, the buccal and palatal bone plates surrounding the ankylosed tooth were thin, making the risk of bone plate and bone height loss during the extraction procedure or healing process significantly high. As a result, extraction was not the primary choice of treatment, unless the ankylosed tooth was infected or if the other available treatment options were unsuccessful.\footnote{4}

Decoration is recommended by Dr Malmgren in 1984 to preserve the alveolar ridge in an ankylosed site, particularly in growing patient.\footnote{13–15} The objective of the surgical procedure is to utilize and enhance the replacement root resorption of the ankylosed root by bone tissue. This involves removing the crown and pulp tissue or canal filling after elevating a mucoperiosteal flap. Then inducing intracanal bleeding is necessary to enhance root

Figure 5. The ankylosed incisor was placed on a higher position bracket to correct the deepened overbite with a sectional NiTi wire.

Figure 6. The procedure of decoration. a. The ankylosed incisor was in a relatively forward position before surgery; b. The coronal portion was removed below bone margin 2 mm; c. The crown was fixed on main archwire with a bracket after surgery; d. Four months after decoration.
replacement. The tooth targeted for the decoronation procedure must be free from infection, such as apical lesions or periodontitis. Infection represents a primary factor contributing to the failure of decoronation, encompassing not only pre-existing infections prior to the surgical intervention but also those that may emerge during or after the procedure. Previous studies and case reports have predominantly focused on the treatment of growing patients with decoronation. One rationale is the elevated rate of bone metabolism in younger patients, which may increase the likelihood of achieving complete replacement root resorption of the residual root fragment compared to adult patients. Another consideration is that implant placement often necessitates a deferral of several years in

Figure 7. Post-treatment photographs. The bilateral molar relationship was in Class I. The profile was straight without lip incompetence and mentalis strain.
growing patients; therefore, decoronation serves as a means to preserve the alveolar ridge during this interim period.

In the current case, the prosthodontic treatment also needed to be postponed until the completion of orthodontic treatment. Thus, the appropriate approach to address aesthetic concerns and prevent alveolar bone loss after extracting the ankylosed tooth is to remove the crown with a prosthesis fabrication and retain the root within the alveolar to maintain the bone volume. While adults may exhibit a diminished probability of achieving complete replacement root resorption following decoronation, several case reports have demonstrated the advantages of performing decoronation on ankylosed teeth in adult patients prior to implant placement. Importantly, even if the remaining root has not undergone fully replacement resorption by the surrounding bone, this does not compromise the success rate of subsequent dental implant placement. The primary rationale for choosing this treatment option since it is less invasive comparing to osteotomy and odontectomy. Given the patient’s dentophobia, the decoronation surgical procedure

Figure 8. Post-treatment radiographic. The root of ankylosed incisor still existed in the panoramic film.
was more readily accepted, as it presented a less aggressive treatment option.

In this case, the decoronation procedure was not performed at the beginning of the orthodontic treatment. During the retraction of the protrusive anterior teeth, a bowing effect could potentially cause the extrusion of the incisors. To prevent such vertical side effects during retraction, the ankylosed incisor was used as absolute anchorage in this case. As a result, the decoronation procedure was carried out after the extraction space of the premolars had been closed. After surgery, the cervical portion of the crown was reshaped with composite resin, and the crown was fixed onto the main archwire with a bracket to address aesthetic concerns during the final stage of the orthodontic treatment.

The final outcome for this patient was positive. The protrusive profile was improved through lip retraction and an increase in chin projection achieved by mandible counterclockwise rotation. This was attributed to the active posterior vertical control provided by bilateral IZC screws and the anterior vertical control ensured by the ankylosed incisor in the upper arch. Following the decoronation procedure and cantilever prosthesis fabrication, the ankylosed incisor did not hinder the profile transformation or disrupt the harmony of the smile. This treatment plan carried fewer risks and had lower costs comparing to other treatment options. After the remaining root fragment is entirely replaced by bone tissue, the implant surgery will be considered as a suitable option. However, if there is the presence of any signs of infection, the surgical removal of the residual root becomes necessary. Hence, the remaining root fragment requires long-term follow-up to monitor the progress of replacement root resorption.

CONCLUSION

In the management of a challenging bimaxillary protrusion case involving an ankylosed maxillary central incisor, a comprehensive approach is crucial. This includes precise diagnosis, thoughtful treatment planning, meticulous design of orthodontic mechanics, and seamless collaboration among experienced interdisciplinary teams. By such a comprehensive approach, it is possible to achieve favorable esthetic outcomes and maintain periodontal health for the patient.

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ETHICAL APPROVAL

Not required.

PATIENT CONSENT

Provided.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES


