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Solving the Complications of Treating a Unilateral Submerged and Ankylosed Maxillary Permanent First Molar – A Case Report

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SOLVING THE COMPLICATIONS OF TREATING A UNILATERAL SUBMERGED AND ANKYLOSED MAXILLARY PERMANENT FIRST MOLAR – A CASE REPORT

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The study reported an adult orthodontic case with a unilateral ankylosed upper permanent first molar. A number of complications occurred, including occlusal plane canting, dental midline deviation and asymmetric molar relationship. The case demonstrated the mechanics used to solve all the complications we met. The case also showed the phenomenon that after extraction of the ankylosed tooth, the bone remodeling mechanism of the bone in situ seemed abnormal and resulted in difficulty of protracting the tooth into the extracted site. All the above reasons, therefore, resulted in prolonged treatment time. In addition, the case also demonstrated the method we used to correct the uneven clinical crown by intrusion of the anterior teeth to solve the unaesthetic attrition problem. Ultimately, the treatment result was stable and with better aesthetics. (Taiwanese Journal of Orthodontics. 29(3): 168-181, 2017)

Keywords: ankylosed permanent molar; submerged tooth; infraocclusion; TADs; anterior crossbite

The diagnosis of ankylosis is critical especially to the patient receiving comprehensive orthodontic treatment. 1,2,3 In the situation of submerged tooth without ankylosis, the treatment goal is to relieve the crowding or remove obstacles over the submerged tooth and level the submerged tooth into occlusion. However if the submerged tooth is actually ankylosed, by the time we level and align the dentition, several complications appear. 4 The complications include occlusal plane canting, midline deviation and asymmetric molar relationship which all are difficult to resolve. 1,4 Therefore, levelling an ankylosed tooth is never the treatment plan without combining interdisciplinary procedures to dislodge the ankylosed tooth. 4 Alternatively, we can move the 2nd molar to substitute the ankylosed 1st molar to accommodate the unfavorable position of the ankylosed tooth.

In this case report, we tried to leveling the mild submerged permanent 1st molar (#16) which was suspected as ankylosis, and simultaneously retracted the canines to relieve crowding first to see whether #16 was ankylosed or not. Further complications like those previously mentioned, occurred: occlusal plane canting, asymmetric posterior anchorage value, and dental midline deviation. To solve the complications properly,
we extracted #16 and used temporary anchorage devices (TADs) to deal with the situation. The details of the treatment procedures will be presented.

**CASE REPORT**

The patient was a 23-year-old female, her chief complaint being canine block-out and anterior crossbite. She had a normal facial form, mild facial asymmetry with chin deviation to the right (3mm), and straight profile with ANB=-1.5º, revealing a mild skeletal class III with retrusive upper lip. Intra-oral examination showed a reverse overjet (-2 mm) with deep overbite (5 mm) and incisal edge attrition. There was severe crowding over the upper arch and mild crowding over the lower arch. The molar relationship was mild Class III (R’t:4mm, L’t: 1mm) (Figure 1). Most specially, we noticed that there was infra-occlusion of #16 about 3.5 mm with marginal ridge height discrepancy.

![Figure 1. The pretreatment record of the patient. It showed mild skeletal class III, anterior crossbite and Class III molar relationship. There was an infra-occluded upper right 1st permanent molar. The submerged amount was about 3.5mm.](image)
TREATMENT PLAN

In order to relieve crowding, correct anterior crossbite, and correct class III molar relationship, the treatment options include:

Option 1.
Extraction of upper 2nd premolars (#15, #25) and lower 1st premolar (#34, #44).

Option 2.
Instead of #15, extraction of upper right 1st Molar (#16) to avoid occlusal plane canting that may be caused by the infra-occluded #16.

As the teeth #15 and #25 were previously RCT and were crown restored, we also could not be sure whether the #16 tooth was ankylosed. Also, an atypical treatment plan with extraction molar and an asymmetric extraction pattern may lead to an unnecessarily complicated treatment. After discussion with the patient, especially as she was unwilling to have a crown-restored tooth (#15) retained, we decided to choose the first treatment option as the definite treatment plan. Risk of ankylosis of #16 and the related complications were disclosed to the patient.

After extraction, the spaces were planned to be closed with moderate anchorage in the upper arch and maximum anchorage in the lower arch. The infra-occluded #16 must be extruded to level the occlusal plane and protruded after the crowding was relieved. The anterior teeth will be build-up to correct attrition after incisors intrusion.

TREATMENT PROGRESS

After premolars extraction, the upper 1st premolars were retracted with segmented T-loop TMA wire to relieve anterior crowding and en-masse retraction with the sliding mechanism was done for lower dentition. After premolar retraction of the upper arch was finished, we noticed that #16 was still submerged and neither sign of anchorage loss nor extrusion were found (Figure 2).

The reverse overjet was then corrected by retracting the lower anterior teeth and the space was closed. After leveling and alignment, we found obvious occlusal plane canting. At the 16th month (Figure 3), the PA cephalometric film revealed right side upward canting of
the occlusal plane, so the ankylosis of #16 was definitely diagnosed.

After communication with the patient and informed consent, the ankylosed #16 was extracted. We then attempted to protract and extrude #17 and #18 by anchorage loss in substitution for #16. To solve the complications caused by #16, we also used TADs over the upper left posterior side for whole arch distalization over the left side to correct dental midline and meanwhile intrusion of the left side and to correct occlusal plane canting.

Furthermore, two TADs over the lower arch bilaterally for total arch distalization to correct molar relationship and intrusion of the lower right posterior region to correct occlusal plane canting.

The second molar (#17) was protracted within 6 months, but there was severe tipping (Figure 4). Over the next few months, the treatment focused on uprighting the severely tipped molar and correcting the occlusal plane canting. There was an intrusive arch over the upper arch to tip-back, upright and extrude #17. However, after trying for another 6 months to upright #17 by intrusion arch or uprighting spring, the mesial movement of the root was yet not obvious. Still severe mesial tipping of #17 was seen (Figure 5). It may be implied that the metabolism

![Figure 4](image1.png)

**Figure 4.** After extraction of #16, the protraction movement of #17 was carried out. However, severe tipping of #17 was noticed and was found very difficult to upright. The intra-oral photos showed intrusive arch over upper dentition for root uprighting of protracted #17 on the 28th month of treatment.

![Figure 5](image2.png)

**Figure 5.** We try to upright the protracted #17 for another 6 months. Comparing to Figure 4, there was limited uprighting of #17.
of the bone block over the ankylosed tooth site had an abnormal response to the orthodontic protracting force even though the ankylosed tooth #16 was extracted. Therefore, we continued to upright and protract #17, and at the same time, we accepted the anterio-posterior and vertical position of #17 and needed more distalization and intrusion of the upper left side dentition with a screw to solve the asymmetric molar relationship and occlusal plane canting problems. Figure 6 shows the mechanism used to intrude and distalize the upper left and lower right dentition by TADs and 16x22 TMA lever arm.

As the occlusal plane canting problem was gradually solved, incisal edge attrition with gingival disharmony was noted. After intrusion of #21 and #22 to achieve the correct vertical tooth and gingival position, we gradually built up the correct size and morphology of #11 and #21. At the 44th month of treatment (Figure 7), the occlusal plane canting was corrected and the harmony of an aesthetic anterior teeth was displayed.

**TREATMENT RESULT**

Because the patient had to study outside the city, the period between each appointment was longer than usual. The total treatment time was 46 months. The fixed appliances were then removed (Figure 8). The occlusal plane canting caused by the submerged #16 was corrected (Figure 9). The soft tissue profile and smile esthetic was improved. And the complications caused by the ankylosed tooth were solved. The cephalometric superimposition revealed a large amount of protraction of #17 (about 14

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**Figure 6.** The mechanism we used to correct occlusal plane canting. The lever arms made with 16x22 TMA wire hooked at distal side of canine extend from upper left screw and lower right screw, which provided the intrusion force. And an elastic thread over #26 to screw for distalization and intrusion. Also the whole lower dentition was distalized by bilateral buccal shelf screws. In addition, we repositioned the bracket of #21 for intrusion it to even the the gingival line and create the space of resin build-up to the correct crown size.

**Figure 7.** Intrusion and distalization of the dentition were done for about 8 months. The occlusal plane canting was corrected. Teeth #11, #21 was build-up with composite resin after intrusion of #21 and canting correction.
Figure 8. Post-treatment photographs and radiographs.

Figure 9. Comparison of the PA cephalometric films. The occlusal plane canting caused by the ankylosed tooth was corrected.
mm). Both upper molars extruded (#17 extruded: 5 mm; #26: 2.5 mm), which caused the mandible to be downward and backward rotated (Figure 10). We used wrap-around Hawley retainers as permanent retention. Figure 11 shows 3-month follow-up after the retainers had been delivered. The treatment outcome was stable.

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**Figure 10.** Cephalometric analysis and superimposition of the cephalometric radiographs of the pre-treatment and post-treatment result. Black line, before treatment; red line, after treatment.

**Figure 11.** Three-month follow-up. The occlusion was stable.
1. Differential diagnosis of submerged tooth

There are several possibilities for the cause of infraocclusion. They can be categorized into two main groups: biologic dysfunction and mechanical obstruction. The biological dysfunction group includes: (1) primary failure of eruption (PFE), which is caused by a mutation in the PTH1R gene; and (2) ankylosis occurred at a young age, so there was no vertical eruption compared with neighboring teeth. The causes that were classified as mechanical obstruction are: (1) crowding that prevents vertical eruption; (2) cyst/tumor that influences the vertical eruption pathway; and (3) Lateral tongue thrust causing no room for vertical eruption. In the mechanical obstruction group, orthodontic treatment can be accomplished after removing the barrier. However, the treatment might be very difficult and complicated when we face the biological dysfunction situation.  

Primary failure of eruption is characterized by eruption failure of permanent teeth in the absence of mechanical obstruction or syndrome. The first molar has the highest prevalence of permanent teeth. PFE is considered a gene related disease. The progress of eruption will be ceased and it will result in infraocclusion. The features of this condition are significant posterior open bite malocclusion accompanying normal vertical facial growth and the affected tooth will not respond normally to orthodontic force.  

Ankylosis is a pathologic fusion of the cementum or dentin of a tooth root to the alveolar bone. According to Biederman and Moyers, ankylosis in deciduous teeth is about 10 times more likely than in the permanent dentition. The incidence of deciduous-tooth dentoalveolar ankylosis was reported to be 1.5% to 9.9%. Ankylosis is likely to occur if periodontal ligament damage permits endosteal progenitor cells from the adjacent bone marrow to repopulate the defect rather than root-side periodontal ligament progenitor cells. It is most likely to affect a replanted avulsed tooth or a severely intruded tooth. In healthy patients, abundant periodontal ligament fibroblasts block osteogenesis within the periodontium, thereby maintaining separation of tooth root from alveolar bone.

Necrosis of the periodontal ligament’s cellular elements disrupts this normal mechanism. This disruption allows growth of bone across the periodontal ligament and fusion of the tooth root and alveolar bone. It can happen to any region around embedded teeth and there is no known treatment to arrest this condition.

To be aware of the ankylosed teeth and make the right differential diagnosis when treating infraocclusion is extremely important, especially for orthodontic treatment, because the affected tooth will no longer respond to orthodontic force and will result in many complications if careful attention is not paid. The efficiency and outcome of orthodontic treatment can be unsatisfactory and need even more effort to fix it. Therefore, when we are dealing with an infraocclusion tooth, the differential diagnosis is most important. If there is no tooth or obstacle which may have previously blocked the eruption pathway or prevented the submerged tooth from vertical displacement, we should suspect there is a biological dysfunction with high chance of ankylosis.

Clinical findings in ankylosed tooth include:

(1) lack of physiological mobility; (2) metallic percussion sound when >20% of root surface is affected; and sometimes (3) infraocclusion. However, the different diagnosis of ankylosis is difficult. The reliability of the Miller index is debatable due to variability in experience of the clinician and their interpretation of the index values. The Periotest (Siemens/ Medizintechnik, Bensheim, Germany) has been described as an objective method for diagnosis of ankylosis but its suitability for use in dental traumatology is questionable. Radiographic findings may reveal resorption lacunae are filled with bone which indicated missing of the PDL. Radiographic examination is considered to be of limited value in the early detection of ankylosis because of the 2-dimensional nature of the
image and the insufficient resolution of the narrow PDL space. Furthermore, the initial location of ankylosis is often on the labial and lingual root surfaces, complicating radiographic detection. Recently, CBCT examination gave us the chance to glimpse the whole 3-D image of the tooth structure, which may help to detect the discontinued PDL.

To distinguish PFE from ankylosis, the definitive diagnosis of PFE is currently made through the identification of a mutation in the PTH1R gene. The two can sometimes be clinically indistinguishable just by clinical examination without knowing of any prior trauma history. Identification can be done by detecting an intact periodontal ligament space, evaluating orthodontic treatment response, or, the most accurate, obtaining genetic information for the patient.

So, as we confront an infra-occlusion tooth, and we want to confirm whether it is ankylosed or not before the orthodontic treatment takes place, the thinking process to differential diagnosis may be suggested as below: First, make sure there is no obstacle that may hinder the eruption pathway. If there really is a physical barrier (e.g. lateral tongue thrust, crowding, or cyst), the cause of infraocclusion is more likely to be mechanical obstruction, not an ankylosed tooth. Second, the history of dental treatment and trauma should be asked. For example, progressive infraocclusion was observed. Also, the clinical findings can give us a hint: metallic percussion sound, no physiologic mobility, and replacement resorption by radiographic interpretation. Third, observe the position of the affected tooth and ask family history. PFE is prone to affect the first 1st molar and needs gene identification to confirm. If the infra-occlusion tooth is not the 1st molar and no family history was reported, and it meets both conditions mentioned earlier, ankylosis of the tooth is highly suspected.

Another method for differential diagnosis is to give the tooth an orthodontic force. We could certainly call a tooth ankylosed if it still does not move when all other obstacles which hinder the orthodontic progress are eliminated. Although a clinical diagnosis can be made by history, percussion, mobility testing and radiology, sometimes lack of orthodontic movement is the only way of confirming the diagnosis.

2. Treatment Strategy and Common Complications

All the treatment strategies for a diagnosed ankylosed tooth can be divided into three categories. One is to leave the infra-occluded tooth in its original position and build up the proximal and occlusal contacts artificially. The second category is to move the ankylosed tooth to the desired position with the aid of surgical intervention. It can be done by immediate replantation, surgical luxation followed by orthodontic traction, or by performing an osteotomy distraction osteogenesis to reposition the dentoalveolar structures. The other strategy is to extract the ankylosed tooth and to either restore with prosthesis or to close spaces orthodontically is acceptable.

The difficulties and complications we may encounter during treatment include: (1) the progressive infraocclusion of the ankylosed teeth, and even after treatment, especially there is still vertical growth; (2) midline shift to the ankylosed side; (3) need to correct the occlusal plane canting causing by ankylosed tooth or causing by the extruded antagonist tooth; and (4) if we extract a severely infra-occluded tooth, large vertical bony defects may occur and need further periodontal surgery to correct it.

A) Part I: management of complications

According to the initial record, there was 3.5 mm infraocclusion of the upper right first molar (#16) and molar mesial shift (3 mm) of the upper left first molar (#26). In the beginning it was considered that the cause of infraocclusion was crowding or obstacles during its eruption, i.e. disarrangement of the eruption sequence due to the delayed exfoliation of the primary 2nd molar and ectopic eruption of #16 (which may result in eruption of #17 prior to #16). The physical examination showed
neither obvious metallic percussion sound nor missing of the PDL in x-ray films. Besides, it is not realistic for the patient to run the genetic test for diagnosis of PFE, so we hoped the movement of #16 would happen after relieving the posterior crowding.

After the initial phase of treatment, the canines were retracted and the signs of ankylosis became more obvious—#16 had no response to the orthodontic force produced by the segmented T-loop spring and still showed class III molar relationship over the right side but class II molar relationship over the left side. If #16 was not an ankylosed tooth, it should move mesially during canine retraction, and extrusion at the same time. However, #16 was definitely an ankylosed tooth, and the following complications occurred:

1. Occlusal plane canting: the teeth adjacent to #16 was all brought upward and create not only posterior but also anterior cant of the occlusal plane.

2. Dental midline deviation: because there was no anchorage loss over the right side molar during space closure, dental midline shifts to right side

3. Asymmetric molar relationship: Due to uneven anchorage during space closure of the upper arch, the right side was molar Class III and left side, Class II.

Because the ankylosed #16 cannot be moved and it caused unwanted complications as mentioned above, we had two treatment options: first, keep the #16 in the original place, and have no choice but to move all other teeth to accommodate the high position of #16 which include intrusion of the upper left side dentition and absolute retraction of the anterior teeth. All would result in compromised dish-in profile. So, the alternate treatment plan was chosen. We removed the ankylosed tooth #16 and aimed at protraction and extrusion of #17 to substituted #16 and to achieve minimum anchorage preparation. Meanwhile, we used intrusive arch as an uprighting spring to upright #17 root and extrude #17.

Also, in order to solve the complications, we added TADs over the upper left posterior region and lower right region with lever arms to provided the intrusion force to correct the occlusal plane canting and whole dentition distalization over the left side to correct dental midline (Figure 6).

As the treatment went on, we faced another difficulty during the protraction of molars of the upper right side. The protraction of #17 was mainly with mesial crown tipping only. It seemed that the bone over the previous ankylosed region (#16 region) had some problems of bone metabolism that might result in abnormal bone remodeling when receiving orthodontic force. Thus the treatment time for root uprighting was prolonged.

We had also found a similar phenomenon in another patient, who had a traumatic intrusive ankylosed upper right central incisor (Figure 12).
The treatment goal was to substitute #11 with #12. After retraction of the anterior teeth, the bone over the extraction site did not resorb and stayed in the originally forward position. As a result, a large bulky protruded mass was observed at the apical position of the upper anterior region after the treatment was completed (Figure 13). There was abnormal bone remodeling mechanism over the alveolar bone of the previously ankylosed tooth site. The explanation of this unique situation may need further research.

Since #17 was too difficult and slow to protract a lot, we had no choice but to accommodate the position of #17 at that time. And two more TADs over lower arch for whole dentition distalization was used. Overall, the upper left infraygomatic screw was for intrusion and distalization over the upper left dentition to correct the occlusal plane cantuage and midline deviation. The lower bilateral buccal shelf screws were for distalization of the whole lower dentition to compensate the Class III molar relationship to achieve Class I molar relationship. If no ankylosis existed, the additional TADs application would not be needed.

B) Part II: esthetic management of anterior teeth

Dr. Kokich\textsuperscript{22} suggested four principles for restoring an aesthetic anterior teeth:

- **Principle 1:** Defined the correct occlusal plane using the fixed landmarks (i.e., the lower vermilion border of upper lip at rest)
- **Principle 2:** Set the vertical position of incisal edge and determine which teeth have “over erupted” and are causing the deep overbite. It also helps to decide which arch should be intruded.
- **Principle 3:** Display of a harmony gingival line and crown proportion. Sulcus depth helps to reveal the correct diagnosis of the correct gingival margin and determine the clinical crown length. In addition, the incisors could be abraded as a result of a bruxism habit. We may need space to restore these teeth to a longer and correct length. In other words, these teeth may need to be intruded further.
- **Principle 4:** Evaluation of facial proportion. If the ratio between lower anterior facial height and upper anterior facial height is more than 55%, orthognathic surgery will be considered to improve facial proportion.

\textbf{Figure 13.} The post-treatment photographs of the patient in Figure 12. The tooth #11 was extracted substituted with #12. Note the protruded firm bone over the region of previously extracted #11. This phenomenon was similar to our previous case that abnormal remodeling of the bone over the ankylosis region.
In this case, after we corrected the posterior occlusal plane canting, there was still gingival disharmony of the anterior teeth and also shortness of clinical crown of #11 and #21. The morphology and tooth size of these crowns is disproportionate. It was possibly caused by attrition and gradually extrusion due to anterior crossbite. So, we need to intrude the upper left dentition, and set the ideal incisal position base on the new occlusal plane. On the other hand, the gingival margin of the maxillary central incisors was coronal to that of maxillary canines and the width-to-length proportion of the maxillary incisor was about 1:1. This all indicated there is attrition of the upper incisors that may need further intrusion of upper anterior teeth and restoration of #11 and #21 with a longer clinical crowns. As a consequence, #11 was intruded for about 2 mm and #21 for about 3 mm to even the gingival margin. After that, #11 and #21 were built-up with composite resin to lengthen the crowns. The appropriate width-to-length proportion of the crown and gingival harmony was finally achieved with correct vertical incisor position related to the upper lip (Figure 14 and 15).

![Image](image1)

**Figure 14.** In our case, the bracket of #11, #12 was repositioned near the incisal edge to intrude #11,21 and meanwhile correct occlusal plane canting by lever arm. The result showed correction of the uneven gingival margin and create space to rebuild the crown size of #12 with composite resin.

![Image](image2)

**Figure 15.** The posed smile view of Figure 14. As the gingival margin was harmony and the crown size was corrected, the patient revealed an esthetic smile.
CONCLUSION

1. This case had shown the importance of the differential diagnosis of a submerged tooth, especially when ankylosis was suspected. Complications happen when dealing with ankylosed molar, such as occlusal plane canting, midline deviation and asymmetric molar relationship. TADs will be needed to solve the complications and also require more treatment time.

2. After the ankylosed tooth had been extracted, abnormal metabolism of bone of the previously ankylosed site still existed and slowed the rate of bone remodeling. It had made orthodontic movement extremely difficult and this had a lot to do with the prolonged treatment time. This phenomenon needs further research and investigations.

REFERENCE


