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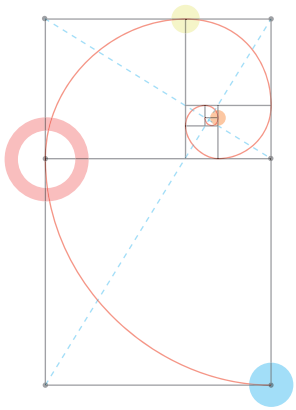

Orthodontic Treatment of a Complex Open-Bite Malocclusion With Temporary Anchorage Devices: A Case Report

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ABSTRACT Orthodontic temporary anchorage devices provide a novel alternative to orthognathic surgery for the treatment of severe anterior open-bite malocclusions. These implantable devices provide skeletal anchorage for maxillary molar intrusion, allowing for mandibular autorotation and subsequent open-bite closure. This case demonstrates step-by-step treatment of a 41-year-old woman with a severe open-bite malocclusion. Detailed orthodontic mechanics are described at every stage of treatment.

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Temporary anchorage devices, TADs, are implantable oral devices that have recently become part of the standard orthodontic armamentarium. They have dramatically expanded the scope of routine orthodontic treatment for both adult and adolescent patients due to their ability to provide skeletal, or "absolute," anchorage.[1] TADs are available in multiple forms including palatal implants and surgical miniplates, but recent attention has been given to the "miniscrew" or "microimplant."[2]

Microimplants are small-diameter temporary implants that are not intended to osseointegrate, but rather rely on cortical retention for stability.[3] Microimplants have become popular amongst orthodontists due to their low cost, ease of placement, effectiveness at treating a variety of malocclusions, and their ability to be used as direct or indirect anchors for orthodontic tooth movement.[2] Furthermore, their small diameter allows for a wide range of surgical sites, including inter-radicular placement.

Prior to the advent of TADs, severe open-bite malocclusions were generally treated with orthognathic surgery.[4,5] With TADs, it is now possible to intrude the maxillary posterior teeth and achieve mandibular autorotation and anterior bite closure without the use of osteotomies.[6] It is also possible to correct an occlusal plane cant.[7]

Several published reports have demonstrated the clinical utility and success of this technique.[8,9] However,

FIGURE 1A.

FIGURE 1B.

FIGURE 1C.

FIGURE 1D.

FIGURE 1E.

FIGURES 1A–E. Pretreatment extraoral photographs. Poor smile esthetics, occlusal cant, long lower face height, bimaxillary retrusive profile.

the specific steps involved in managing the orthodontic mechanics and the timing of various treatment stages are not as well documented. The aim of this paper is to highlight the step-by-step clinical treatment of a complex open-bite malocclusion with microimplants from diagnosis through retention.

Case Report

Diagnosis, Treatment Goals, and Treatment Plan

A healthy 41-year-old woman presented with a chief complaint of, "I want to fix my bite and eat normally." Clinical examination revealed a severe open-bite malocclusion with occlusal contact only on the right third molars. Other significant findings included a tapered maxillary arch form, a mandibular midline deviation, wear facets on the posterior teeth, a cant of the occlusal plane, and mild mandibular anterior crowding. The patient reported a history of orthodontic treatment as an adolescent during which three premolars (Nos. 5, 12, and 29) and the mandibular left third molar (No. 17) were extracted. She also reported nonpainful clicking of the temporomandibular joints 10 years prior to this examination. No recent clicking or temporomandibular joint pain were reported by the patient or noted during the examination.

General orthodontic treatment goals for this patient included improvement in static and functional occlusion, periodontal stability, dental esthetics, and facial harmony. Specific goals were to close the bite, establish anterior guidance, eliminate the cant of the occlusal plane, close the mandibular plane angle, and improve the smile esthetics by leveling the maxillary arch and modifying the maxillary arch form.

Initially the patient was presented with an orthognathic surgery plan that she rejected due to her fear of surgery. TAD-anchored intrusion was then presented as a viable alternative to orthognathic surgery and the patient accepted this treatment plan, although she delayed starting treatment due to her phobias of dental treatment. She was informed that extraction of the third molars would probably be necessary in order to achieve bite closure. She was also informed of microimplant risks, including the possibility of implant failure that could necessitate replacement in the midst of treatment.

Treatment

The following steps were taken in the clinical management of this patient:

1. Orthodontic diagnostic records were taken, including mounted models in centric relation (**FIGURES 1A–S**). In addition to the standard orthodontic records, an MRI of the temporomandibular joints was ordered to assess the etiology of the open bite. Review of the MRI revealed bilateral anterior disc displacement without reduction, a condition associated with the development of anterior open bite.[10,11] However, from review of the medical and dental history and thorough review of the MRI, it appeared that the patient had reached an endpoint in significant joint changes and was stable. Due to the lack of TMD symptoms, no specific therapeutic modalities for the temporomandibular joints were recommended. A significant amount of time between the initial records and the

FIGURE 1F.

FIGURE 1G.

FIGURE 1H.

FIGURES 1F–J. Severe open bite and flattened cusps on the mandibular molars, indicating a history of progressive occlusal changes.

FIGURE 1I.

FIGURE 1J.

FIGURE 1K.

FIGURE 1L.

FIGURE 1M.

FIGURES 1K–M. Pretreatment mounted casts, labial view.

FIGURE 1N. Pretreament-mounted casts, right lingual view.

FIGURE 1O. Pretreatment mounted casts, left lingual view.

FIGURE 1P.

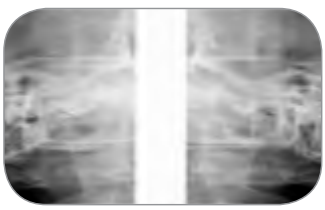

FIGURE 1Q.

FIGURE 1R.

FIGURE 1S.

FIGURES 1P–S. Pretreatment radiographs.

start of treatment, due to the patient's phobia of treatment, allowed for further confirmation of the clinical stability of the joints and the occlusion.

2. Model surgery was performed on a duplicate set of mounted dental casts to assess the results of extracting the remaining third molars. After partial bite closure was observed on the casts, the remaining third molars were extracted. The amount of clinical bite closure noted after the extractions (**FIGURES 2A–C**) closely matched the model surgery and confirmed the accuracy of the centric relation mounting.

3. Orthodontic treatment began with the banding of the maxillary molars using custom-soldered hooks on the palatal aspect of the first molar bands (to allow for easy application of elastic chain for intrusion), and surgical placement of (1.5 mm diameter, 6.5 mm length) microimplants (Spider Screw, OrthoTechnology, Tampa, Fla.) on the mesiobuccal and distobuccal aspect of the maxillary first molars.[12] Another microimplant was placed in the

FIGURE 2A.

FIGURE 2B.

FIGURE 2C.

FIGURE 2A–C. Postextraction of third molars. Note partial bite closure.

FIGURE 3A.

FIGURE 3B.

FIGURE 3C.

FIGURES 3A–C. Start of active orthodontic treatment; placement of buccal microimplants on right and left sides, and one microimplant to the right of the midpalatal suture.

FIGURE 3D. Note the transpalatal arch. It was removed at the next visit to allow for easier unilateral intrusion.

palate to the right of the maxillary midline suture (**FIGURES 3A–D**).The microimplants were self-drilling and were inserted transmucosally under local anesthesia. Multiple buccal implants were utilized in order to maximize anchorage and to allow for precise biomechanical control.

A transpalatal arch was also initially cemented in order to avoid buccal tipping of the molars during the application of intrusion forces. However, this transpalatal arch was removed after one visit to allow for easier unilateral intrusion mechanics on the right side. The palatal microimplant served in place of the transpalatal arch to help counteract any tendency for the molars to tip buccally.

Intrusion was initiated on the right side and the intrusion force was provided by an elastomeric chain that was attached from the right buccal and palatal microimplants to the maxillary right first and second molars. Since the application of force extended directly from the implant to the tooth, this is an example of "direct anchorage."

4. The palatal microimplant became mobile within three weeks of initial placement and was replaced at the next regularly scheduled visit. Additionally, the buccal microimplant between the right first and second molars was intentionally removed as it was originally placed too far occlusally and interfered with the intrusion mechanics due to contact with the buccal attachment on the second molar band. In place of this microimplant, another one was inserted distal to the second molar. The replacement of these microimplants did not impede the patient's progress and demonstrates the flexibility of this technique in adapting to biological and mechanical challenges.

5. After four months of treatment, the right molars were significantly intruded and the only occlusal contact was on the palatal cusp of tooth No. 4 (**FIGURES 4A–D**). In order for the mandible to autorotate and the bite to close, it was imperative to remove this contact. Therefore, a button was bonded on the palatal aspect of No. 4 and an elastomeric chain was attached from the button to the existing palatal implant.

6. Three weeks later, the palatal cusp of No. 4 was intruded and the sole occlusal contact was on the right canines. The patient reported severe discomfort due to the rapid change in her occlusion. The maxillary arch was immediately bonded (**FIGURES 5A–C**), and the maxillary right molars were held in an intruded position to serve as an indirect anchorage unit for intrusion of the right canine and for leveling of the occlusal plane with a round nickel-titanium archwire. The goal was to level and intrude the maxillary right canine without allowing molar extrusion. This goal would not have been achievable with traditional orthodontic mechanics, and therefore this stage of treatment highlights the clinical significance and novelty of the microimplant technique.

7. As No. 6 intruded and the last anterior interference was removed, the mandible autorotated and the bite began to close (**FIGURES 6A–D**). The cant of the maxillary occlusal plane also improved significantly.

8. Three and a half months after the bonding of the maxillary arch, a slight positive overbite was achieved and the left molars were in occlusion. In order to allow for further deepening of the overbite, the maxillary left posterior teeth required intrusion. Therefore, another palatal microimplant was placed to the left of the midpalatal suture and buccal and palatal intrusion forces were introduced on the left side. This addi-

FIGURE 4A.

FIGURE 4B.

FIGURE 4C.

FIGURES 4A–D. After three months of intrusion of the right molars, the sole contact was on the palatal cusp of No. 4. This contact was preventing autorotation of the mandible, so no change in the anterior open bite was yet observed. An elastic chain was attached from the existing palatal implant to a button bonded to No. 4.

FIGURE 4D.

FIGURE 5A.

FIGURE 5B.

FIGURE 5C.

FIGURES 5A–C. Maxillary arch was bonded and the right molars served as an indirect anchorage unit for intrusion of the right canine and leveling of the occlusal plane with the archwire.

FIGURE 6A.

FIGURE 6B.

FIGURE 6C.

FIGURES 6A–D. The maxillary arch is leveling and the bite is closing due to removal of occlusal interferences and autorotation of the mandible.

FIGURE 6D.

tional palatal implant was part of the initial treatment plan but was delayed until clinically necessary in order to prevent potential tongue irritation.

Since the right molars already were slightly out of occlusion, a light elastic force from the right palatal implant was used to keep them from erupting but no further active intrusion on the right side was necessary. This light force to the right second molar also helped improve its palatal crown torque. The mandibular arch was also fully bonded at this time (**FIGURES 7A–D**).

9. After four months of further intrusion (fully active on the left, light on the right), 2.5mm of overbite was achieved (**FIGURES 8A–D**) and the cant of the occlusal plane was corrected. Since the initial treatment goals were met, intrusion mechanics were stopped, but the microimplants were left in place in the event that they would be needed to counteract a relapse tendency. The total intrusion process was completed in 12 months.

10. Over the next seven months, the palatal microimplants were removed and detailing wires were used to perfect the alignment and the occlusion (**FIGURES 9A–D**).

11. The patient was debonded after 19 months of total treatment time and the microimplants were removed without incident and without the use of local anesthesia. Temporary thermoplastic retainers were immediately fabricated and Hawley retainers were delivered three months later.

12. Final records (**FIGURES 10A–L**)

FIGURE 7A.

FIGURE 7B.

FIGURE 7C.

FIGURE 7D.

FIGURES 7A–D. Occlusal contact of the left molars. In order to continue anterior bite closure and increase the overbite, intrusion of the left side was begun. The lower arch was also bonded at this time. Light intrusion of the right side (from the palatal only) continued in order to prevent extrusion of the right molars and to improve the crown torque of the maxillary right second molar.
.

FIGURE 8A.

FIGURE 8B.

FIGURE 8C.

FIGURE 8D.

FIGURES 8A–D. End of active intrusion.

FIGURE 9A.

FIGURE 9B.

FIGURE 9C.

FIGURE 9D.

FIGURES 9A–D. Detailing archwires in place. Palatal microimplants were removed.

were taken two months after debonding. Cephalometric superimpositions (**FIGURES 11A–C**) confirmed absolute intrusion of the maxillary molars and autorotation of the mandible. Facial assessment revealed an improvement in smile arc, profile, and occlusal cant. Mounted models in centric relation confirmed a coincident relationship of centric occlusion and maximum intercuspation.

13. Nine-month post-treatment records showed excellent stability (**FIGURES 12A–H**). Long-term results on the stability of this technique were not yet available in the orthodontic literature at the time of publication.

Discussion

TADS vs. Orthognathic Surgery

An anterior open bite is recognized as a difficult orthodontic problem to correct in adult patients, especially when the etiology of the malocclusion is skeletal in nature. Although there are methods to camouflage the open bite with pure orthodontic tooth movement, orthognathic surgery has been the most stable and reliable method in the past for treating anterior adult open bite. However, there are significant limitations to orthognathic surgery, including cost, postoperative downtime, and surgical risks associated with general anesthesia. Other surgical risks may include vascular and neurological complications, infection, and risk to teeth and other vital structures.[13] Therefore, a technique that would achieve similar results to orthognathic surgery, without its limitations and risks, would be beneficial.

Orthodontic temporary implants now provide such an alternative. Despite the fact that TADs are relatively new in orthodontics, they have quickly proven to be an extremely effective aid in treating a wide range of complex malocclu-

FIGURE 10A.

FIGURE 10B.

FIGURE 10C.

FIGURES 10A–C. Improvement in facial and smile esthetics.

FIGURES 10A–L. Final photos (two months post debond).

FIGURE 10D.

FIGURE 10E.

FIGURE 10F.

FIGURE 10G.

FIGURE 10H.

FIGURE 10I. Panoramic radiograph showing good root alignment.

FIGURES 10D–H. Ideal occlusion and alignment.

FIGURE 10J. Cephalometric radiograph displaying closure of mandibular plane angle and leveling of occlusal plane.

FIGURE 10K.

FIGURE 10L.

FIGURES 10K–L. Improvement in appearance of teeth at rest and upon smiling.

sions.[1] In many open-bite cases, TADs can eliminate the need for orthognathic surgery altogether, as shown here. In a recent study, Kuroda et al. showed that in open-bite cases, TADs are as effective in reducing facial height and increasing positive overbite as orthognathic surgery, without incurring the associated risks.[6]

Despite the success of microimplants and other TADs in correcting anterior open bites, a significant role still remains for orthognathic surgery. TADs are an excellent modality for treating vertical problems; however, they are limited in their ability to correct severe anteroposterior problems. Orthognathic surgery is favored, alone or in conjunction with TADs, in cases with a significant skeletal class II or class III component to the open bite.

Risks Associated With Use of Microimplants

Due to the fact that microimplants are not intended to osseointegrate and rely on cortical anchorage, the main risk associated with their use is implant failure. Failure of a microimplant is determined by clinical mobility and an inability to provide stable skeletal anchorage. This generally necessitates

FIGURE 11A. Full cephalometric superimposition. Note counterclockwise rotation of mandibular plane and forward movement of hard- and soft-tissue chin point (Pogonion). Black= Pre-treatment; Red=Post-treatment.

FIGURE 11B. Maxillary superimposition. Significant intrusion of maxillary molars, and mild retraction of the incisors.

FIGURE 11C. Mandibular superimposition. Mild proclination of the incisors. No significant change in molar position.

FIGURE 12A.

FIGURE 12B.

FIGURE 12C.

FIGURE 12D.

FIGURE 12E.

FIGURE 12F.

FIGURE 12G.

FIGURE 12H.

FIGURES 12A–H. Nine-month post-treatment follow-up displaying excellent esthetics and occlusal stability.

removing the implant and replacing it in an adjacent or alternative area of better bone or soft-tissue quality.

Another potential risk of using microimplants is injury to an adjacent vital structure such as a tooth root or a neurovascular bundle. This risk is mitigated by thorough knowledge of oral anatomy and careful review of appropriate diagnostic imaging. Surgical stents can also be used to help with accurate surgical placement.[14]

Recent studies have measured the success rate of microimplants to be from 84 percent to 93 percent.[15,16] Implant success is dependent on several variables, but initial mechanical stability and the type of force applied to the microimplants are important factors.[17]

Practitioners using these devices should be prepared for some measure of clinical failure and should incorporate these potential events into the treatment plan and informed consent. However, due to the ease and low cost of replacing a microimplant, it is rare for failure of an implant to significantly impact the progress of treatment.

Conclusions

This case report demonstrates the orthodontic treatment of a severe open-bite malocclusion with orthodontic temporary anchorage devices known as microimplants. By using microimplants as skeletal anchors, the maxillary molars were intruded and significant bite closure was achieved. When presenting treatment options to patients, microimplant-anchored intrusion should be considered as a viable alternative to orthognathic surgery for effective treatment of severe open-bite malocclusions. ■■■■

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