MICROSCREW IMPLANT ANCHORAGE SLIDING MECHANICS

Aim: To show the effectiveness of sliding mechanics used with microscrew implants in managing a dentoalveolar protrusion. There are several advantages, including reduced treatment time, simplified treatment mechanics, early profile changes, and elimination of interarch mechanics. Material and Methods: A step-by-step procedure for microscrew implant anchorage sliding mechanics is shown, with records of treated patients, which demonstrate the aforementioned advantages of this technique. The associated biomechanics and theoretical explanation follow. Results: The authors show how the microscrew implant can provide anchorage for en masse retraction of six anterior teeth and the efficiency and ease of the mechanics in managing a dentoalveolar protrusion. Conclusion: The microscrew implant offers orthodontic clinicians a minimally intrusive method of intraarch anchorage that can retract the anterior teeth without the anchorage loss that is expected in conventional techniques. Sliding mechanics used with microscrew implants is shown to be simple and efficient. World J Orthod 2005;6:265–274.

Traditionally, canines have been distalized prior to en masse retraction of incisors in the hope of reducing the mesial movement of the posterior teeth, i.e., anchorage loss. With preadjusted appliances, there are approaches to retract the six anterior teeth simultaneously. In these approaches, the anchorage control is considered one of the most important factors for successful treatment.

With the use of skeletal anchorage in orthodontic treatment, such as dental implants, miniplates, and mini- or microscrews, orthodontists could expect absolute anchorage for tooth movement. The required spaces for dental implants, however, are so large that the arch cannot accept those without edentulous ridge space. Roberts et al. and Wehrbein et al. have chosen the retromolar area and palate to place the dental implant, and have extended the complexity of the appliances, to connect the implant to the anchor teeth. On the other hand, the microscrew implants are small enough to be placed into the dental arch between the roots of the teeth, and have been incorporated into orthodontic treatment without discernible harm. The ease of placement and removal, low cost, and the capability for early loading after placement could expand treatment indications for many clinical situations.

The utilization of skeletal anchorage in full-arch treatment, however, has not been extensively studied. This clinical report will illustrate the microscrew implant anchorage (MIA) sliding mechanics and its efficacy in bialveolar protrusion treatment.

MIA SLIDING MECHANICS PROCEDURE

The step-by-step procedure of the MIA sliding mechanics is as follows:
Maxillary arch

1. Placement of a microscrew implant into the alveolar bone between a second premolar and a first molar on both sides (Fig 1)
2. Bonding of 0.022-inch preadjusted appliances and transpalatal bar for maintaining an archform, not for anchorage reinforcement (Fig 2a)
3. Partial canine retraction; a canine is tied back to the microscrew implant (Fig 2b)
4. En masse retraction of six anterior teeth (Fig 2c) via 0.016 × 0.022 archwire with anterior hooks between lateral incisors and canines; nickel-titanium (NiTi) closing coil spring connects the anterior hooks to the microscrew implants and applies 150 g of force on each side
5. Finishing; occlusal settling with vertical elastics

Mandibular arch

1. Placement of the microscrew implant between the first and second molars on both sides
2. Partial canine retraction; the canine is tied back to the second premolar
3. En masse retraction of the six anterior teeth via 0.019 × 0.025-inch archwire
4. Application of an intrusion force to upright and intrude the mandibular molars by ligating an elastic thread from the microscrew implant to the mandibular archwire (Fig 2d)
5. Finishing

Detailed procedures for the surgical placement of the microscrew implants have been discussed in previous reports.11–14

There is less of a need to apply lingual root torque to prevent lingual tipping...
during anterior tooth retraction because it is possible to utilize force passing near the center of resistance of the anterior tooth segment in the maxillary arch (Fig 3a). In fact, a 0.016 × 0.022-inch archwire in 0.022-inch slot brackets cannot exert lingual root torque on the anterior teeth because of the play between the bracket slots and the archwire. The anterior teeth, however, could be retracted bodily by using the force passing close to the center of resistance.12,13

The methods controlling the mode of the anterior tooth retraction are the occlusogingival position of the microscrew implant, the height of the anterior hooks, and the amount of torquing curve given on the archwire. The microscrew implants should be placed in a low position, ie, approximately 4 mm gingival to the archwire when applying a distalizing force in nonextraction.18 The position should be 8 to 10 mm gingival to the archwire when retracting six anterior teeth in extraction treatment.19 The lower the microscrew implant is placed, the greater the expected lingual tipping movement of the anterior teeth. The torquing curve incorporated into the archwire affects the mode of the incisor retraction (see Fig 3a). By moving the canine distally 1 or 2 mm prior to the incisor retraction, clinicians can increase the lingual tipping of the maxillary incisors (Fig 3b).

The mandibular microscrew implant can be used to apply intrusive force on the mandibular posterior teeth. The intrusion force not only up droits and intrudes the mandibular molars slightly, but also helps the mandibular posterior teeth maintain their uprighted angulation during space closure (Fig 3c). The anterior movement of the mandibular molars, while maintaining their uprighted position, can close the mandibular plane angle, which results in an increase of the SNB angle, a reduction of the ANB angle, and an overall improvement of the facial profile (Fig 3d). This is especially true in a young growing patient; in adults the change should be limited.

Characteristics of the MIA sliding mechanics are as follows:

- It allows for the bodily retraction of the six maxillary anterior teeth, while utilizing the force near the center of resistance.
- It could induce early changes of the profile by simultaneously retracting the six anterior teeth.
- Uprighting and slight intrusion of the mandibular molars induces the autorotation of the mandible and contributes to the improvement of the profile.
- Simultaneous retraction of the incisors with the canines reduces treatment time.
A female patient, 22 years of age, had a lip protrusion (Fig 4). The cephalometric measurements revealed that the patient had an ANB angle of 2.5 degrees and a high mandibular plane angle (36 degrees) (Table 1).

Intraorally, Class I canine and molar relationships were evident, and the overjet and overbite were normal. The patient had a 2-mm deficiency in the arch length in both arches and a 2-mm curve of Spee.

The treatment plan called for the extraction of the four first premolars and maximum retraction of the maxillary anterior teeth with the aid of maxillary microscrew implants as anchorage. The mandibular microscrew implants were planned for vertical control of the mandibular posterior teeth.

**CASE REPORT**

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Treatment progress

During the extraction procedure, the authors placed a maxillary microscrew implant (AbsoAnchor AX12-108, Dentos, Daegu, Korea) into the alveolar bone between the second premolar and first molar, and a mandibular implant (AbsoAnchor AN12-204, Dentos) between the first and second molar on both sides. Immediately after placement, two radiographs from different angles were taken to determine the relationship of the microscrew implants with the adjacent roots (see Fig 4).

After inserting a leveling archwire, the NiTi coil springs with minimal activation were implemented in the maxillary arch. Exerting approximately 50 g of force, the coil springs were attached from the microscrew implants to the canines to prevent any forward tipping movement of the canines. This application of the NiTi coil force was started 2 weeks after placement of the microscrew implants.

After 2 months of treatment, a 0.016 × 0.022-inch archwire with anterior hooks was inserted and a NiTi coil spring force of 150 g on both sides was applied to retract the six maxillary anterior teeth (Fig 5). In the mandibular arch, an intruding force of 100 g was applied by connecting the elastomeric thread from the microscrew implant to the archwire on both sides. This helps the uprighting of the mandibular molars during space closure.

No intermaxillary elastics were used, except for vertical elastics on the anterior teeth during the settling of the occlusion.

Treatment results

The treatment was completed after 18 months. The patient had a well-balanced face and a good dental interdigitation
with Class I canine and molar relationships (Fig 6). The facial profile was improved with the retraction of the upper and lower lips (a 1.8-mm retraction in the upper lip and a 5-mm distal movement of the lower lip) (see Table 1). Cephalometric superimpositions showed that the maxillary anterior teeth were retracted with a 6-mm distal movement and a 2-mm intrusion (Fig 7). The maxillary posterior teeth were moved 2.5 mm distally, concurrent with the retraction of the anterior teeth. The mandibular posterior teeth maintained their vertical position and showed mesial root movement, and the anterior teeth were uprighted. The FMA angle was reduced from 36 degrees to 35.5 degrees.

The microscrew implants did not show signs of mobility or failure during treatment and could provide sufficient anchorage for the retraction of the anterior teeth. There was no obvious root resorption (Fig 8).

**DISCUSSION**

The retraction of the six anterior teeth with sliding mechanics, where a main archwire slides through the posterior brackets, provides many advantages. It offers minimal wire bending and adequate space for activation.1–3 The control of anchorage, however, can be a major problem, which makes clinicians hesitate...
Fig 7  Cephalometric superimpositions.

Fig 8  Pre- and posttreatment panoramic radiographs.
to accept these mechanics, especially in maximum anchorage cases.

The microscrew implants provide absolute anchorage for tooth movement and they can be placed into the arch, which expands the clinical applications.\textsuperscript{11-17} In this patient, the maxillary posterior teeth, which are normally a reactive anchorage part in conventional orthodontic treatment, moved distally against the microscrew implant. This means the microscrew implant provided the anchorage for the distal movement of the whole dentition.

The combination of these two treatment modalities, microscrew implant anchorage with sliding mechanics, can maximize the efficiency of retraction of the maxillary anterior teeth in maximum anchorage cases. By utilizing sliding mechanics, clinicians have the advantage of minimal wire bending and adequate space for activation. By retracting six anterior teeth simultaneously, the treatment time can be reduced and the profile changes can be achieved in the early stages. By making retraction forces pass near the center of resistance, by controlling the occlusogingival position of the microscrew implants and the vertical hook heights on the archwire, the treatment mechanics can be simplified. There is no concern about the anchorage.

There was almost no torque effect by twisting the 0.016 × 0.022-inch archwire in the 0.022-inch slot brackets. The mandibular anterior teeth in this patient, however, did not show much lingual torque during retraction, even though there was clearance between the archwire and the bracket slot. These results coincide with those of previous reports.\textsuperscript{12,13,19} There are some possible reasons for the maintenance of incisor inclination. First, the force passes near the center of resistance of the teeth. The upward and backward retraction forces can be generated from the NiTi coil springs connected from the microscrew implants, placed 8 to 10 mm gingival to the bracket slots, to 3- to 5-mm-long anterior hooks on the archwire. The forces in this configuration pass much closer to the center of resistance than the ones applied at the level of brackets. There should be less demand for labial crown torque to prevent lingual tipping of the incisors. Second, the torqueing curve bend is applied on the anterior segment of the archwire. The torqueing curve provides an intrusive force on the incisor brackets, and the intrusive force generates labial crown torque on the incisors. Third, the six anterior teeth are retracted simultaneously with sliding mechanics. The archwire has enough rigidity without a loop in the extraction space, and it does not distort since there is sufficient rigidity and a comparatively light force (150 g). The maxillary canine tends to maintain its angulation during retraction. The archwire with a torqueing curve applies an intrusive force to the incisors. It can be proven that the incisors show lingual tipping when retracting incisors after moving the canine distally.

Since the anterior inclination can be dictated by the control of the force direction, the torqueing curve on the archwire, and the retraction of six anterior teeth with sliding mechanics, the need for a heavy archwire is decreased. Heavy archwires are known to produce more friction than lighter archwires.\textsuperscript{20} Therefore, the 0.016 × 0.022-inch archwire in the 0.022-inch bracket system produces less friction than the 0.019 × 0.025-inch archwire and facilitates tooth movement. Much play between the archwire and the bracket slot could permit the archwire to be engaged in the early stages and contribute to the reduction in treatment time. When breakage of the bracket occurs during retraction, the heavy archwire needs to level the teeth to be engaged securely into the slots. The light archwire, however, can be engaged into the slot without leveling, in most instances. Thus, retraction of the anterior teeth can be continued without interruption.

The mode of anterior tooth retraction, ie, lingual tipping or bodily movement, should be monitored by taking cephalometric radiographs. It is more feasible and efficient to control the inclination of the maxillary anterior teeth during retraction, in which there is remaining space to close. After the closure of the space, it is difficult and time consuming to change the tooth inclination.
The amount of tooth movement can be controlled by the continuation and discontinuation of force. The continuation of the force after space closure can move the whole dentition distally.11,12 In some instances, the posterior teeth have shown distal movement during anterior teeth retraction even though extraction space remained to be closed. The reason for this could be friction between the archwire and brackets. Since all the teeth may move, the movement of teeth should be monitored by periodic cephalometric and panoramic radiographs.

By retracting the six anterior teeth simultaneously, the treatment time is reduced. The reduction of the treatment time is obtained not by rapid tooth movement but by simultaneous tooth movement. Actually, the speed of the movement of each individual tooth in MIA sliding mechanics is slower than with step-by-step retraction of the canine and incisors.

The adult patient with a high mandibular angle has a tendency to bite opening during mechanotherapy.21 The FMA angle in this case decreased during treatment, even though the patient had a high FMA angle (36 degrees). This might be caused by the vertical control of the mandibular molars. The intrusion force that is applied to the mandibular posterior teeth can help the uprighting of the mandibular first molars and the intrusion of the mandibular second molars. The intrusion and forward movement of the mandibular molars can contribute to the closing of the mandibular plane angle. The mandibular counterclockwise response, with the beneficial facial profile changes, follows. This response has obvious benefits in treating a high-angle skeletal Class II malocclusion.22,23 The buccal tipping can be a complication of applying intrusion force from the buccal microimplants; it can be prevented by using the heavy archwire and applying lingual crown torque.

The microscrew implant can reduce the need for intermaxillary elastics, as well as extraoral appliances. In addition, this technique is less dependent upon patient cooperation. The Class II elastics cause lingual tipping and extrusion of the maxillary anterior teeth, and extrusion and mesial tipping of the mandibular posterior teeth. The extrusion and mesial tipping of the mandibular molars can open the mandibular plane angle, especially in high-angle cases. This results in a downward and backward movement of the chin and has a detrimental effect on the facial profile.22 The independent mechanics, however, on the maxillary and mandibular arches can eliminate the need for the Class II elastics. There is a better chance of profile improvement with vertical control of the mandibular molars.

There are concerns about the complications and failures of microscrew implants. Previous reports have shown variable success rates, from 93% for a 1.5-year observation24 to 66% for a 3-month observation period.25 The greatest failure rate (9 out of 12) occurred within 6 months after placement, and six microscrew implants failed within 2 months, indicating that the surgical technique is a crucial factor for success.24 It is technique-sensitive procedure and the success rate varies among clinicians. The factors for success with microscrew implants may include dexterity and surgical skill, careful management of the microscrew implants during use, and oral hygiene control around the microscrew implants. To minimize the chance of failure, the force used should be light and the microscrew implants should be cleaned not with toothbrushes, but with a compressed water spray.

There is barely enough space between the maxillary second premolars and the first molars for the microscrew implants. To prevent root damage, the microscrew implants should be placed at an angle of 30 to 40 degrees to the bone surface in the maxillary arch and 10 to 20 degrees in the mandibular arch, which reduces the horizontal intruding depth.12,13,26 One report,27 which supports this procedure, stated that less than 4 mm of periodontal damage can be recovered without ankylosis. The root damage which might be caused from contact of the microscrew implant to the root would be less than 1 mm because of the small diameter (1.2 mm) of the microscrew.
mation around the microscrew implants is reduced by modifying the shape of the attachment on the head in the new microscrew implant system. Soft tissue impingement around the canine eminence can be reduced by bending the anterior hooks out from the gingiva.

CONCLUSION

Microscrew implants provide anchorage for the retraction of the six anterior teeth without anchorage loss. The combination of microscrew implants with sliding mechanics brings many advantages, such as reduced treatment time, early profile changes, simplified treatment mechanics, and the elimination of interarch mechanics.

REFERENCES