

A new protocol of the sliding mechanics with Micro-Implant Anchorage(M.I.A.)

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Anchorage plays an important role in orthodontic treatment. Because of limited anchorage potential and acceptance problems of intra- or extraoral anchorage aids, endosseous implants have been suggested and used. However, clinicians have hesitated to use endosseous implants as orthodontic anchorage because of limited implantation space, high cost, and long waiting period for osseointegration.

Titanium miniscrews and microscrews were introduced as orthodontic anchorage due to their many advantages such as ease of insertion and removal, low cost, immediate loading, and their ability to be placed in any area of the alveolar bone.

In this study, a skeletal Class II patient was treated with sliding mechanics using M.I.A.(micro-implant anchorage). The maxillary micro-implants provide anchorage for retraction of the upper anterior teeth. The mandibular micro-implants induced uprighting and intrusion of the lower molars. The upward and forward movement of the chin followed. This resulted in an increase of the SNB angle, and a decrease of the ANB angle. The micro-implants remained firm and stable throughout treatment.

This new approach to the treatment of skeletal class II malocclusion has the following characteristics :

- . Independent of patient cooperation.
- . Shorter treatment time due to the simultaneous retraction of the six anterior teeth
- . Early change of facial profile motivating greater cooperation from patients

These results indicate that the M.I.A. can be used as anchorage for orthodontic treatment. The use of M.I.A. with sliding mechanics in the treatment of skeletal Class II malocclusion increases the treatment simplicity and efficiency.

Key word : M.I.A.(micro-implant anchorage), sliding mechanics, skeletal Class II malocclusion

Anchorage control has been considered one of the important factors in the successful treatment of patients. Anchorage problems arise from the fact that all appliances are in balance, i.e. that

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the sum of the moments and forces generated are always equal to zero.¹⁾ However, the orthodontists wants to move the tooth or teeth in a desired direction while the anchor part stays unmoved. Although extraoral appliances can be used to provide stable anchorage, they depend on the patient's cooperation. In order to provide acceptable stable anchorage, endosseous implants have been suggested and used.^{2,3)} But their use for orthodontic anchorage has been limited by space, economy, and long waiting time required for

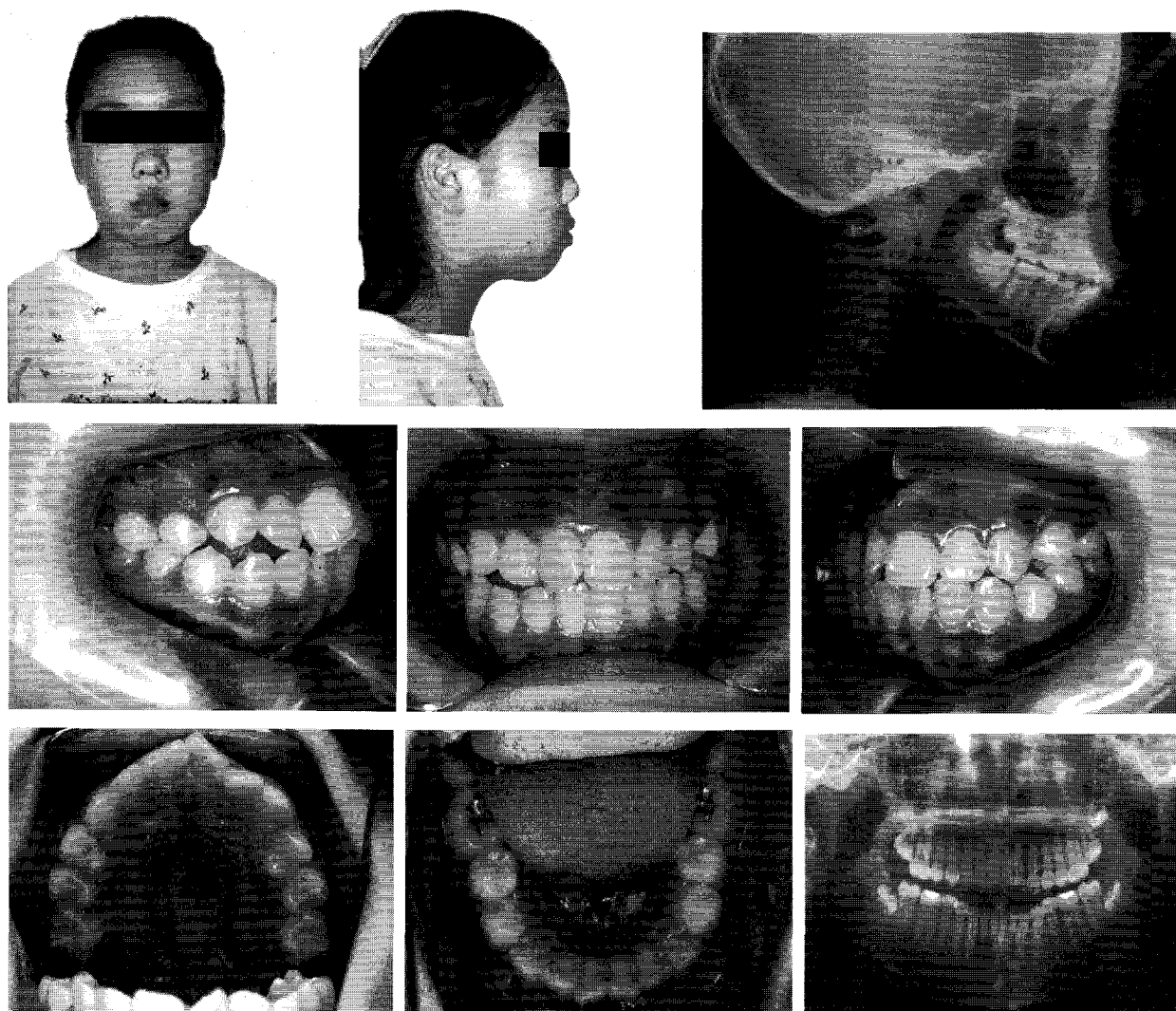


Fig. 1. Facial and intraoral photograph, cephalometric radiograph, and panoramic radiograph before treatment

osseointegration.

Recently, Kanomi⁴⁾ and Costa et al⁵⁾ have introduced the use of titanium miniscrews and microscrews as orthodontic anchorage. The advantages of the microscrews are small size allowing placement in any area of the alveolar bone, ease of implantation and removal, low cost, and a short interval between implantation and orthodontic force application.

This study presents the treatment of a skeletal Class II patient with sliding mechanics using M.I.A.(micro-implant anchorage) featuring a maxillary micro-implant for retracting the upper anterior teeth and a mandibular micro-implant for uprighting the lower mo-

lars. The clinical considerations concerning sliding mechanics with M.I.A. are discussed.

CASE

The patient was a 12-year-old girl whose chief complaints were crowding and lip protrusion.

1. Diagnosis

1) Extraoral findings

The patient had a convex profile. The lateral photo showed protrusion of upper and lower lips and retruded

Table 1. Summary of cephalometric measurements.

Measurements	Pretreatment	Posttreatment
Skeletal		
SNA	77.5	76
SNB	72.5	74.5
ANB	5	1.5
FMA	34	32
PFH/AFH	63(44/69.5)	69.5(49/70.5)
Dental		
FH to UI	119.5	115
IMPA	102	90
FH to occlusal plan	16	13.5
Interincisal angle	105	124
Soft tissue		
Z-angle	51	67
Upperlip to E-line	5	2
Lowerlip to E-line	8	3

mandible(Fig. 1).

2) Intraoral findings

The patient showed Class I canine relationships and Class I(right) and Class II(left) molar relationships. The overjet, overbite, and curve of Spee were 2 mm, 1 mm, and 2 mm, respectively. The patient had moderate arch length deficiency(upper arch, 4.5 mm; lower arch, 2 mm)(Fig. 1).

3) Cephalometric analysis(Table 1)

The cephalometric measurements revealed skeletal Class II with high angle. The FMA angle was 34°, the ANB angle was 5°. The lower incisors proclined severely(IMPA, 102°).

2. Treatment

1) Treatment plan

For the relief of crowding, extraction of upper and lower first premolars was planned. For the provision of anchorage, implantation of maxillary and mandibular microscrews was planned.

2) Treatment progress

After extraction, two 8-mm-long microscrews(1.2 mm in diameter, Osteomed, U.S.A.) was implanted into the buccal alveolar bone between upper second premolar and first molar, one on each side.

* Surgical procedure

Under local anesthesia, a 3 to 5 mm vertical stab incision was made on the alveolar mucosa between upper second premolar and first molar. A small pit (1.5 mm) was made by round bur under saline cooling after reflecting a mucoperiosteal flap. Drilling was performed with a 1 mm diameter drill under saline cooling. A titanium microscrew (Osteomed Co, U.S.A.), 8 mm in length and 1.2 mm in diameter, was inserted with a screwdriver. Two periapical radiographs were taken to check whether the microscrew was placed well between adjacent roots or not.

The straight wire appliances with 022×028 slot were bonded and banded. In order to prevent the upper canines from moving forward during the initial stage of treatment, laceback was performed between micro-implants and canines. One month later a NiTi tension coil spring was used between micro-implant and canine for partial canine retraction. A transpalatal bar was inserted for the purpose of preventing archform distortion, not for the reinforcement of anchorage. At the third month of treatment, the upper anterior teeth were retracted by sliding mechanics. A 016×018 archwire with hooks was inserted and 150 gm force was applied by connecting the NiTi coil spring between the maxillary micro-implants and hooks on the archwire (Fig.2).

In the lower arch, retraction of lower anterior teeth was performed by sliding mechanics with the NiTi coil spring after leveling.

At the sixth month of treatment, a 6-mm-long micro-screw (1.2 mm in diameter Osteomed U.S.A.) were implanted into the buccal alveolar bone between lower first and second molars on each side. Two weeks after mandibular micro-implants implantation, an elastic thread was connected between the mandibular micro-implant and the lower main archwire in order to provide intrusion force on mandibular posterior teeth. This treatment modality was continued until most of the

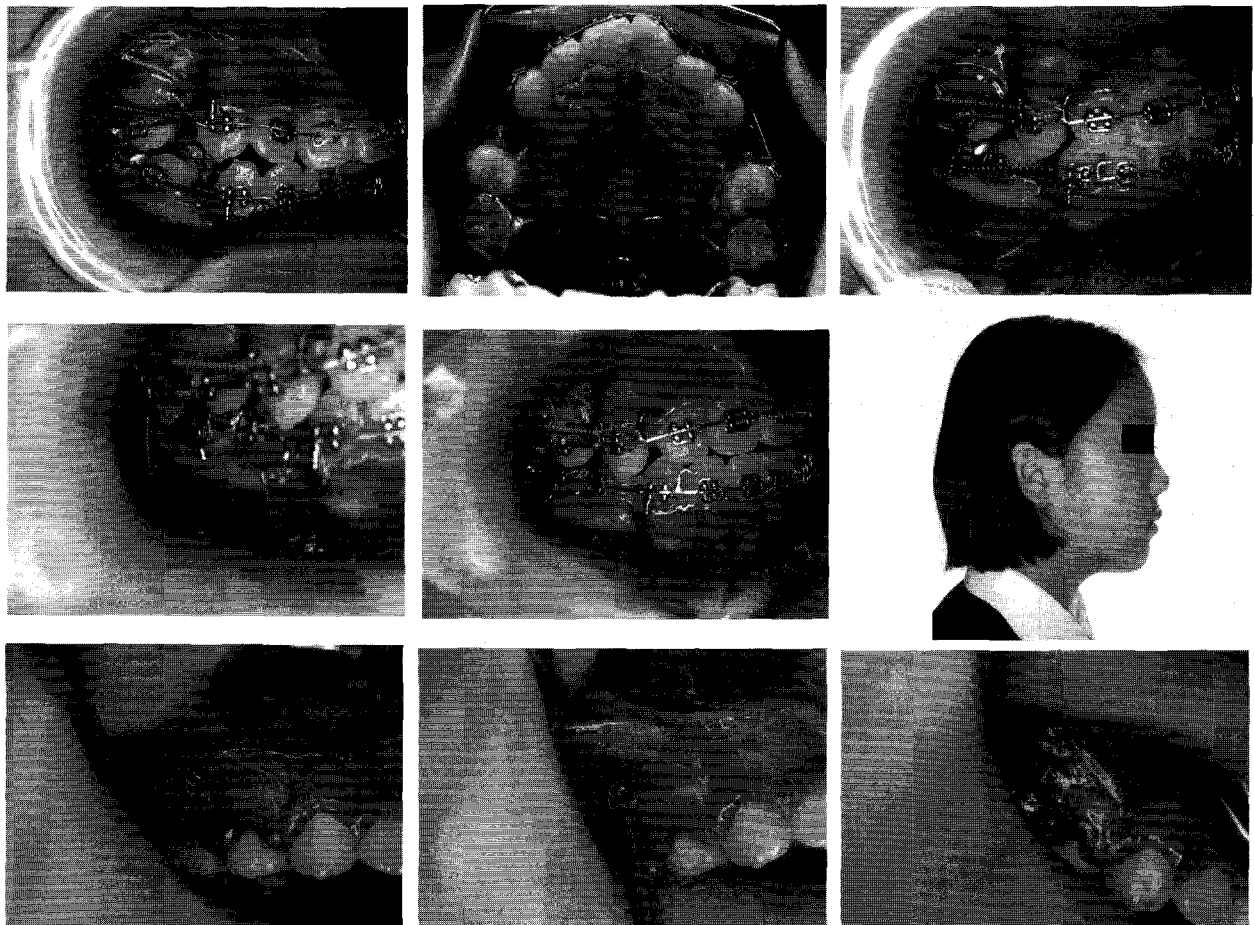


Fig. 2. NiTi closing coil spring between maxillary micro-implant and canine, transpalatal bar for preserving arch form, NiTi coil spring between micro-screw implant and hook on the archwire, mandibular micro-implant between lower first and second molar, elastic thread between lower micro-implant and archwire, facial profile photo after 9 months of treatment., removal of micro-implant.

space was closed.

After most of the space had been closed by the tenth month, power chains were applied between upper first molars and hooks on the archwire for settling the occlusion down. The total treatment time was 14 months.

3) Treatment result

Good facial harmony was obtained by superoposterior movement of upper anterior teeth and forward upward repositioning and enhanced growth of the mandible(Fig. 3 and Fig. 4). The ANB angle was reduced by 3.5 degrees, which was induced by a 2 degree increase of SNB angle and a 1.5 degree decrease of

SNA angle. The FMA angle was decreased by 2 degrees (Table 1). The greatest part of the profile change occurred during the first 9 months of treatment(Fig.2).

The upper anterior teeth showed 6 mm bodily retractive movement and 2 mm intrusive movement and the upper posterior teeth showed a small degree of anchor loss(Fig. 4). The FH to occlusal plane was changed from 16° to 13.5° resulting from the intrusion of upper anterior teeth and from the intrusion and uprighting of lower molars.

DISCUSSION

At times orthodontists encounter problems concer-

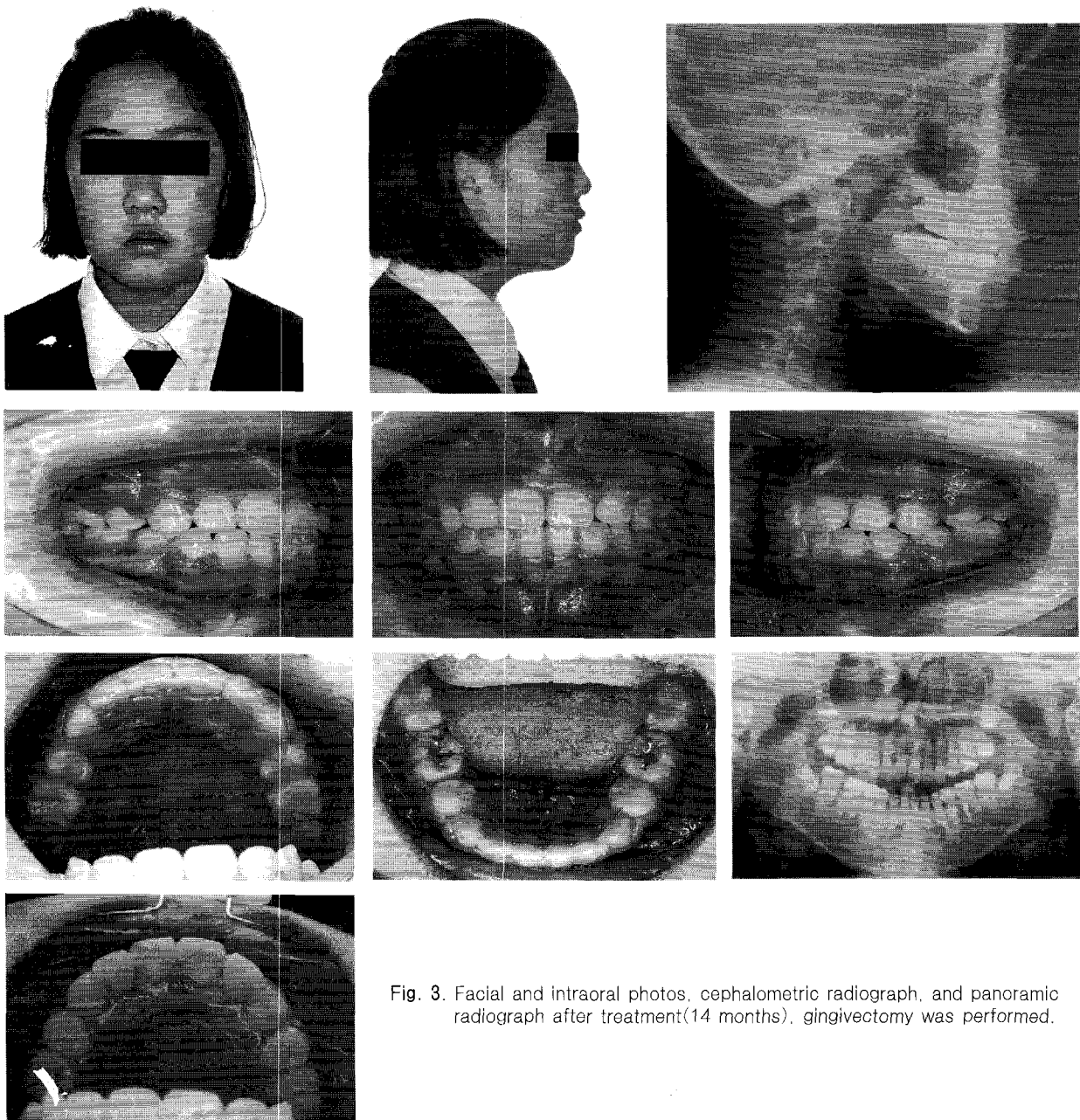


Fig. 3. Facial and intraoral photos, cephalometric radiograph, and panoramic radiograph after treatment(14 months). gingivectomy was performed.

ning lack of anchorage. Noteworthy advancements in endosseous implants may help solve such problems.

More than 50 years ago, Gainsforth and Higley⁶⁾ examined the possibility of vitallium screws in orthodontic anchorage. The next reported use of implants as anchors for tooth movement was by Linkow.⁷⁾ Following these early reports, there were many studies to evaluate the possibility of endosseous implants and

screws as orthodontic^{8,9,10,11,12,13)} and orthopedic anchorage⁴⁾ in animals.

After Branemark et al's research¹⁵⁾, in which successful osseointegration of implants with bone was observed, clinical approaches were performed^{2,3,16)} In 1994, Roberts et al²⁾ presented a retromolar implant which was implanted in the mandibular retromolar area and used to close the extracted lower molar space.

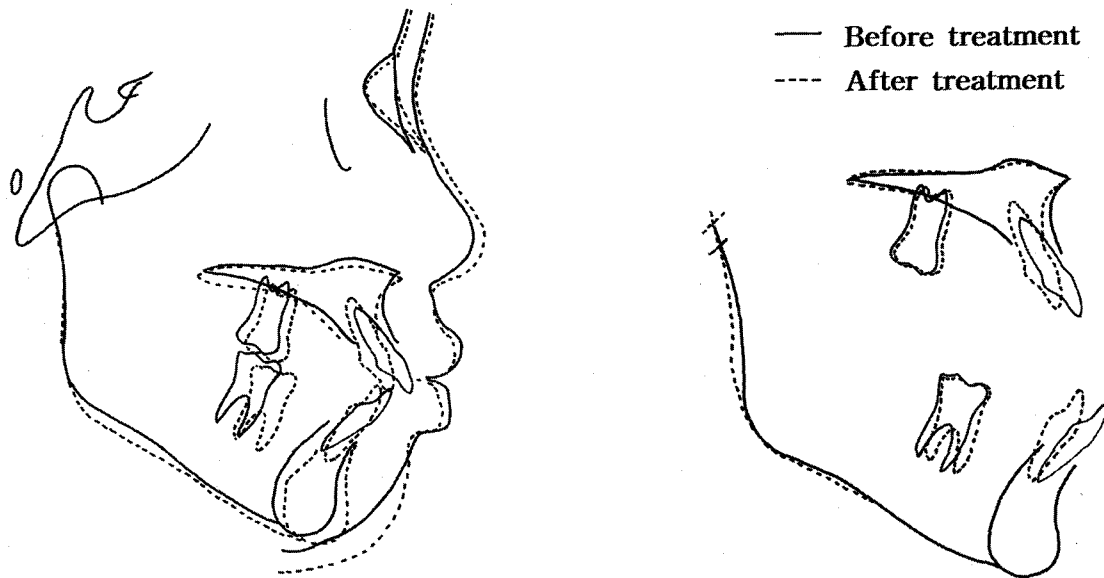


Fig. 4. Cephalometric superimposition of before and after treatment.

Block and Hoffman¹⁷⁾ introduced the onplant which was implanted in the midpalatal area subperiosteally. As mentioned earlier, endosseous implants have many limitations for orthodontic anchorage.

Creekmore and Eklund¹⁸⁾ reported a case of intrusion of upper anterior teeth by using a vitallium screw, which was implanted in the bone just below the anterior nasal spine. Umemori et al¹⁹⁾ reported open-bite cases treated with a skeletal anchorage system using surgical miniplates. Wehrbein et al²⁰⁾ examined the anchor loss using a palatal implant(Ortho System) as anchorage. Recently, Kanomi⁴⁾ and Costa et al⁵⁾ presented the use of small titanium miniscrews as orthodontic anchorage. The use of an osseointegrated implant for orthodontic anchorage has been limited by space, economy, and long waiting time for osseointegration. Although the use of microscrew implants is less extensive than the skeletal anchorage system in surgical procedure, it is not strong enough to withstand heavy force. From a biological perspective, 1 N of force per side is enough for retracting anterior teeth. Concerning the amount of force applied on implants, many researchers have observed that implants could withstand from 1 N to 6 N of force.^{10,16,21)} According to wGary et al's study⁸⁾, a 1.6 mm vitallium screw could

withstand 180 gm of horizontal loading. In the study presented here it was decided to use 150-200 gm of continuous force to retract anterior teeth and the micro-implants remained firm and stable throughout treatment. A NiTi coil spring was selected for force application in order to prevent the heavy force during manipulation.

The mode of tooth movement can be controlled by changing the vertical position of maxillary micro-implants, the height of hooks on the archwire, the amount of accentuated curve of Spee on the upper archwire, and the amount of force. In this case, the force was passed as close as possible to the center of resistance of the upper anterior teeth. By the application of the force close to the center of resistance, the upper anterior teeth were retracted bodily. There was no force inducing anchor loss of the upper posterior teeth during retraction of anterior teeth with M.I.A. But a small degree of anchor loss of upper posterior teeth occurred during the use of the power chains between upper first molars and hooks on the archwire during the finishing stage. In a previous report by the author, 1.5 mm posterior movement of the whole maxillary dentition was achieved by using microscrew implants as an orthodontic anchorage.²²⁾

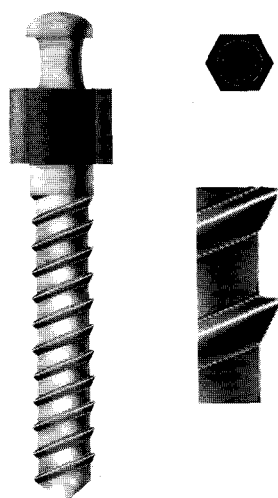


Fig. 5. The new micro-implant.

Because the vector of force passed over the center of resistance of the whole maxillary dentition, the anterior part of the upper dentition showed upward and backward movement, and the posterior part showed downward and backward movement. This positional change resulted in a flattening of the steep occlusal plane. In the process of retraction and intrusion of upper anterior teeth, the extrusion of upper molars occurred. To prevent the opening of the FMA angle, the extrusion of maxillary molars should be prevented, or the mandibular molars should be intruded. The intrusion of mandibular molars is favorable for the flattening of the occlusal plane. Therefore, the mandibular micro-implants were required to induce the intrusion and uprighing of lower molars, allowing the forward and upward movement of the chin to follow. This resulted in an increase of the SNB angle and a decrease of the ANB angle. These changes can be major factors for profile change in skeletal Class II malocclusion. All the changes described above were quite similar to the counterclockwise changes of the occlusal plane and the FMA plane in Tweed-Merrifield directional force mechanics.²³⁾

There was minor inflammation around the micro-implants and the NiTi coil spring. Because ligature wire was used to connect the NiTi coil spring to the

micro-implants, ligated wire around the microscrew neck may have acted as an irritant. Lindhe et al⁹⁾ also found that the placement of plaque retentive ligatures around the implant neck resulted in inflammation. The new micro-implants were developed which have a hook on the head of the microscrew for connecting to the NiTi coil spring or elastics, and a smooth neck contacting the soft tissue(Fig. 5).

The studies that have dealt with the timing of force application after implantation can be divided into two groups. One group of studies stated that the clinician should delay the force application until osseointegration occurred. Roberts et al¹⁰⁾ concluded from an experiment in the femurs of rabbits that immediate loading needed to be avoided. The other group of studies insisted on immediate force application.^{5,24)} As Gray et al observed⁸⁾, osseointegration might not be necessary when using titanium microscrew implants for orthodontic anchorage. He found firm stable screws after force application that had connective tissue encapsulation. In the opinion of the author of this study, once soft tissue is healed it is possible to apply orthodontic force and by applying the force immediately, the total treatment time can be reduced. In the present study, the total treatment time was reduced, and rapid change of profile was obtained by the simultaneous retraction of six anterior teeth.

Skeletal cortical anchorage using micro-implants has just started to be used for clinical purposes. Despite many clinical considerations, such as inflammation and the timing, amount and method of force application, that require scientific clarification, MIA(micro-implant anchorage) may be a good option for reinforcing anchorage.

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국문초록

Micro-Implant Anchorage(MIA)를 이용한 Sliding mechanics

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박 효 상

고정원의 조절은 교정치료에 있어서 매우 중요한 요소로 이를 보강하기 위한 많은 노력이 있어 왔다. 골융합성 임플란트의 경우 확실한 고정원으로서 가능성이 인정되고 있고, 또 임상에서 시도되고 있다. 그러나 임플란트를 매식하기 위해서는 무치악이 존재해야 하거나 하악구치 후방부위에 식립해야 하는 등 장소의 제약이 있고, 값이 비싸며, 골융합을 위하여 기다리는 시간이 필요하다는 등의 단점으로 인하여 보편화되고 있지는 않다.

최근 몇몇 임상가에 의하여 수술용 titanium microscrew 나 miniscrew를 교정치료시의 고정원으로 사용하려는 시도가 있었는데, 이것은 골융합성 임플란트보다 수술이 간단하며, 가격이 저렴하고, 치료할 어느 부위든지 식립할 수 있다는 장점이 있다.

저자는 M.I.A.(Micro-Implant Anchorage)를 고정원으로 사용한 sliding mechanics를 통하여 골격성 II급 부정교합자를 치료하였다. 상악의 M.I.A.는 상악전치의 후방견인의 고정원으로 사용되었고 하악의 M.I.A.는 하악 제1대구치의 직립과 제2대구치의 압하이동의 고정원으로 사용되었다. 하악 구치가 직립됨에 따라 하악골의 전상방 회전이 일어나 SNB각의 증가로 이어지고 ANB각의 감소를 가져왔다. M.I.A.는 치료 전기간동안 안정되게 유지되어 교정치료의 고정원으로서의 가능성을 확인시켜 주었다.

M.I.A.를 고정원으로 사용한 sliding mechanics를 통하여 골격성 II급 부정교합자를 치료하는 새로운 접근법은 환자의 협조도에 의존하지 않고 치료할 수 있고, 비교적 빠른 시기에 많은 안모의 변화를 가져와 환자의 협조도를 끌어 낼 수 있다. 그리고

상악 6전치를 동시에 후방견인하므로 치료기간을 줄일 수 있으며 호선의 교환이 적어 chair time이 짧다.

이런 결과로 미루어 볼 때 MIA는 치아이동의 고정원으로 역할을 할 수 있을 것으로 생각되고, MIA를 고정원으로 이용한 sliding mechanics를 통한 교정치료는 골격성 II급 부정교합의 치료에 있어서 쉽고 효율적인 치료법으로 생각된다.

주요 단어 : 치열교정용 미세 임플란트, 활주역학, 골격성 2급 부정교합