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Research

Invisible treatment of a severe Class I crowding with multilingual bracket system using new double mushroom archwire technique

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ABSTRACT

This case report presents an invisible lingual bracket orthodontic treatment of a 26.5-year-old adult female patient with Class I severe crowding. The patient did not wish to wear any visible appliances, so she was treated with lingual brackets with four second premolar extraction. The lingual brackets and wires used in this case illustrate atypical biomechanics of tooth movement. The Fujita lingual bracket used in this treatment provides unique form and function. It consists of three main slots: occlusal, horizontal, and vertical. The archwires designed for use with this bracket are unique in form, named the mushroom archwire. We placed two main mushroom archwires into the two main slots, occlusal and horizontal slots, simultaneously. We refer to this two main mushroom archwire technique as the double mushroom archwire (DMA) technique. DMA technique makes it possible to prevent dysfunctional tooth movement such as excessive retroclination of incisors and tipping movement of the crowns of canines and premolars. Unwanted uncontrolled tooth movements were minimized by the new DMA technique. The patient was satisfied with her treatment without others noticing her orthodontic appliances. It is possible to achieve bodily movement and apply lingual root torque with the DMA technique. DMA technique has the potential to raise the quality of lingual bracket treatment.

1. Introduction

Fujita is the first orthodontist to present lingual bracket therapy in his article in 1979 [1], and since then, he has been improving the form of the lingual bracket to its current fifth generation [2]. Because lingual brackets are placed on the lingual surface of all teeth and an archwire is engaged in bracket slots on the lingual side of the teeth, orthodontists are required to be in a cramped posture during treatment. The Fujita bracket was developed into a unique form to improve this treatment difficulty for doctors. Fujita refined the form of bracket and treatment procedures through feedback from his experiences and daily practices. The form of the Fujita bracket provides three wire slots: two slots for the main archwires and one slot for an auxiliary wire (Fig. 1).

The specific structure and function of each slot of the Fujita lingual bracket are as follows: An archwire engaged in the occlusal slot works to depress the mandibular incisors and to upright posterior teeth effectively for deep overbite cases in the initial phase of treatment. Using this slot, an orthodontist can easily adjust, insert, and tie an archwire. A continuous or sectional archwire engaged in the horizontal slot works to control the mesiodistal inclination of teeth during tooth movement. The vertical slot is built along the long axis of the bracket. An auxiliary wire is placed in the vertical slot to control crown rotation of the tooth (Fig. 2).

Bracket slot selection during the treatment phase depends on the required tooth movement to achieve treatment objectives. Recently, we employed a technique placing two archwires into both occlusal and horizontal slots simultaneously. These two archwires effectively work to prevent the excessive retroclination of incisors, to control the torque of crown during the space closing phase, and to reduce treatment time.

All authors have completed and submitted the ICMJE Form dos Disclosure of Potential Conflicts of Interest, and none were reported.

Authors have obtained and submitted the patient signed consent for images publication.

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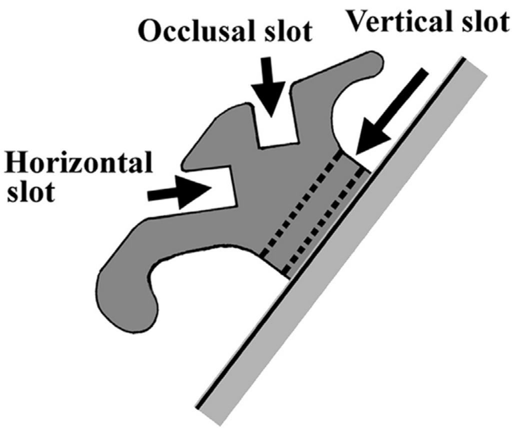

Fig. 1. Form of Fujita bracket.

2. Case report

2.1. Diagnosis and etiology

The patient was a 26.5-year-old woman in good general health. Her chief complaint was difficulty with oral hygiene. Due to her anxiety toward orthodontic treatment, she hesitated to receive treatment using conventional brackets.

Facial photographs before treatment show a straight-type profile (Fig. 3). Her upper lip was slightly prominent with strained mentalis muscles when closing lips. With malpositioned maxillary and mandibular canines, her upper lip appeared thinner than the lower lip. Her occlusion presented anterior teeth crowding with the canines blocked out in both maxillary and mandibular arches. Maxillary and mandibular molars were Class I relationship, while the bilateral canines were Class II relationship. The maxillary lateral incisors were in crossbite. Both dental arches were square form type. The arch length discrepancies of the maxillary and mandibular arches were −8.4 and −7.5 mm, respectively. Though midlines of the maxillary and mandibular dental arches were coincident, the dental midline deviated to the left of the facial midline by 2.5 mm (Fig. 3). There was severe crowding on the left side compared to the right side of the dental arches. The overbite and overjet were 3.5 and 2.5 mm, respectively (Fig. 4).

A panoramic radiograph revealed that all teeth were present except the maxillary third molars. Both right and left mandibular third molars were impacted horizontally (Fig. 5). Her alveolar bones and roots indicated a good healthy condition.

The cephalometric analysis showed that the Sella-Nasion-point A (SNA) angle of 81.6°, the Sella-Nasion-point B (SNB) angle of 80.1°, and the ANB (difference between SNA and SNB) angle of 1.5° were found to be within the normal range for Japanese. The Frankfort Mandibular Angle (FMA) was 18.7° and the Gonial angle was 108.5°. Both of these angles were remarkably small in comparison to Japanese standard [3]. The inclination of maxillary incisors was almost normal value. The inclination of mandibular incisors was slightly proclined. These results indicated that her malocclusion was a skeletal Class I crowding with a flat mandibular plane (Fig. 6, Table 1).

There were no signs or symptoms of temporomandibular joint disorders during mandibular movement.

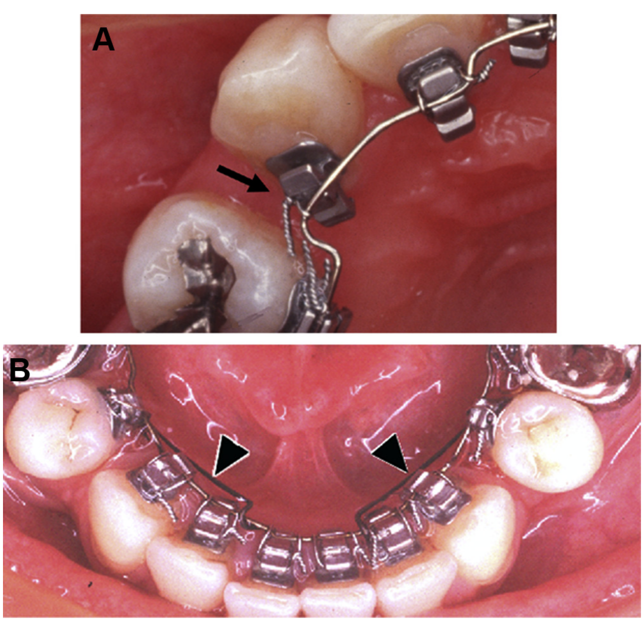

Fig. 2. (A) Ligature wire through the vertical slot tied on distal side to correct canine rotation. (B) Modified uprighting springs were inserted into the vertical slots.

2.2. Treatment objectives

The treatment objectives were to (1) eliminate anterior crowding, especially in the canine region, (2) correct the lateral incisor crossbite, (3) coincide the occlusal midline and facial midline, and (4) improve the form and function of the upper lip and strained mentalis muscles.

2.3. Treatment alternatives

Because the patient did not want to wear any conventional orthodontic appliances, we selected the Fujita multilingual bracket system for her treatment for aesthetic reasons.

We selected the second premolars of both arches for extraction. In conventional labial bracket treatment, the first premolars would have been extracted. In this lingual bracket treatment, the maxillary and mandibular incisors may obscure excessive retroclination during the leveling and closing stages (Fig. 7). Since the archwire is placed on the lingual side of the crown of the tooth, the force exerted by the archwire increases the lingual inclination angle of the incisors. In addition, the force from the lower lip may press the labial surface of the anterior teeth. At the same time, the archwire works to upright the posterior teeth distally, which reinforces the anchorage of the molars. If the first premolar is extracted, it is more difficult to close the remaining space by moving the molars mesially after eliminating the anterior teeth crowding.

2.4. Treatment progress

Both maxillary and mandibular second premolars and impacted mandibular third molars were extracted before the placement of multilingual brackets (the Fujita bracket). Each Fujita bracket provides three slots: an occlusal slot, a horizontal slot, and a vertical slot. The occlusal and horizontal slots are 0.019 × 0.019 in and 0.018 × 0.022 in, and the vertical slot is 0.016 × 0.016 in. At the first phase of treatment, a 0.012-in stainless steel wire (Ormco, Glendora, Calif.) fabricated in a mushroom shape was engaged in the horizontal slot in the mandibular brackets to eliminate the curve of Spee. After 2 months, another 0.014-in stainless steel initial mushroom archwire was engaged in the occlusal slot of the maxillary brackets. Then a 0.016-in stainless steel mushroom archwire was engaged in the maxillary dental arch, and the maxillary first premolars were retracted by elastic thread after the leveling stage (Fig. 8). A 0.014-in stainless steel archwire was added in the horizontal slot in the mandibular

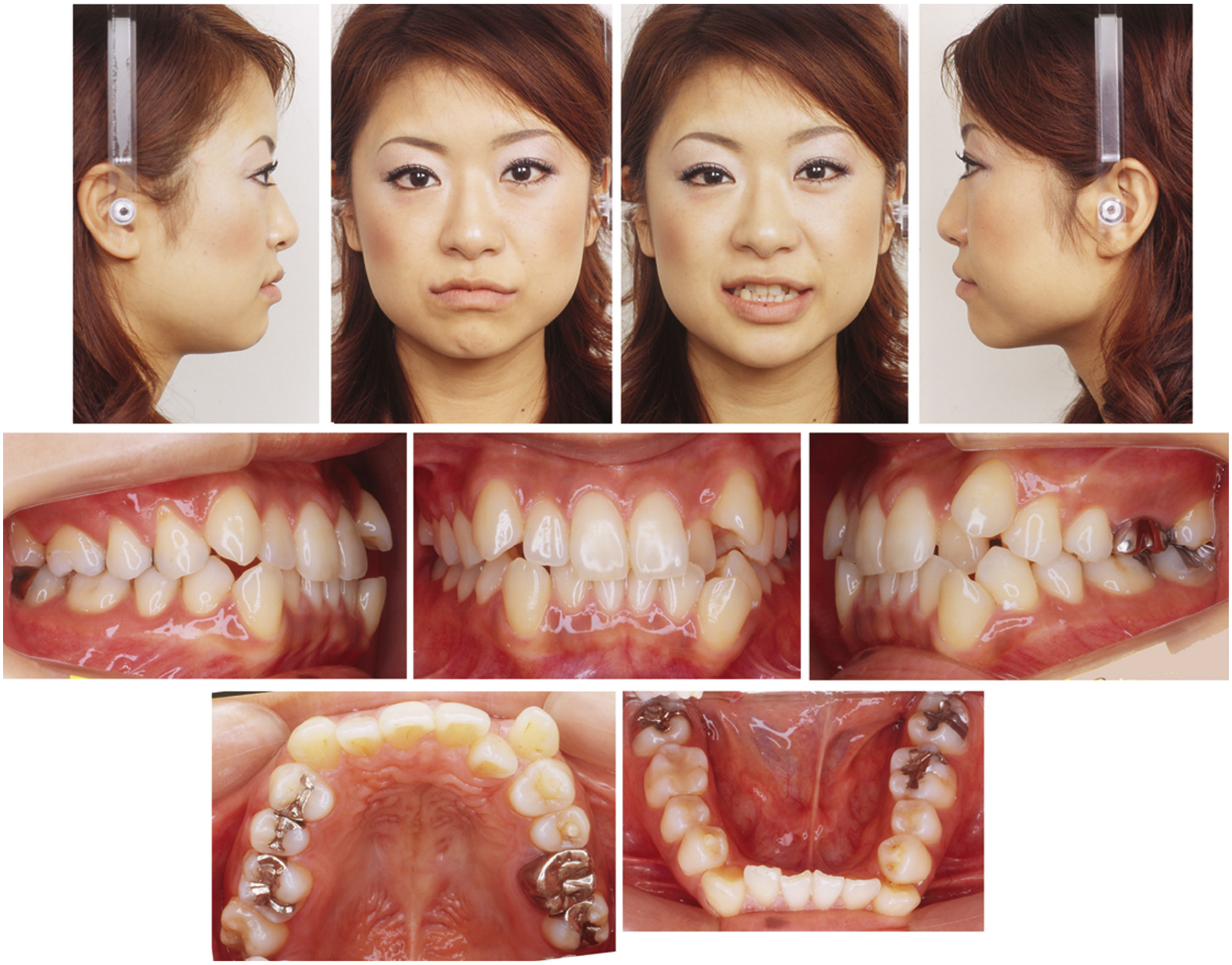

Fig. 3. Pretreatment facial and intraoral photographs.

brackets to continue the leveling. Five months later, after the maxillary first premolar retraction, a 0.012-in Ni-Ti sectional wire was added into the horizontal slots from the right canine to the left first premolar for the correction of the left lateral incisor crossbite. At the same time, a 0.016-in stainless steel mushroom archwire was placed in the occlusal slot, bypassing the left lateral incisor bracket to reinforce the maxillary arch anchorage. Mandibular first premolars were distallized through two 0.014-in stainless steel mushroom archwires in occlusal and horizontal slots with elastic threads after the leveling stage. Two 0.014-in mushroom archwires in both slots results in the bodily movement of the mandibular first premolars (Fig. 9). After the incisors were aligned, a 0.018 × 0.018-in square stainless steel mushroom archwire was inserted in the occlusal slot to maintain the aligned teeth. At the same time, a 0.016 × 0.016-in closing mushroom archwire was placed in the horizontal slot. Both of these two wires worked to apply the labial crown torque to anterior teeth (Fig. 10). Ideal arch form mushroom archwires of 0.018 × 0.018-in stainless steel wire were engaged into the occlusal slot in both arches for 3 months (Fig. 11).

The total active treatment time was 33 months. Following bracket removal, a 0.0195-in twisted-wire (Dentsply, USA) fixed retainer was bonded on the lingual surface of teeth from the right premolar to the left premolars in the mandible (Fig. 12). A removable thermoforming retainer (Tru-tain, USA) was placed in the maxillary dental arch.

2.5. Treatment results

Facial photographs after active treatment showed good improvement in the profile and frontal view of the patient's face due to the corrected blocked out canines and resolved anterior teeth crowding. The upper and lower lips were slightly retruded, and the shape of upper lip was improved. The midline of the dental arch was coincident with the facial midline. The final occlusion showed Class I canine and molar relationships on both sides of the dental arches. The amount of overbite and overjet was 3.0 and 2.0 mm, respectively, and good interdigitation was achieved. The patient revealed that her friends were not aware of her orthodontic treatment (Fig. 13).

Cephalometric analysis showed the skeletal measurement values were almost stable. U1 to SN and L1 to MP angles were slightly retroclined. The changes were confirmed in the superimposed pretreatment and posttreatment lateral cephalometric tracings (Fig. 14, Table 1).

Panoramic radiograph revealed that an acceptable root parallelism was achieved while slight root resorption of the maxillary incisors occurred (Fig. 15).

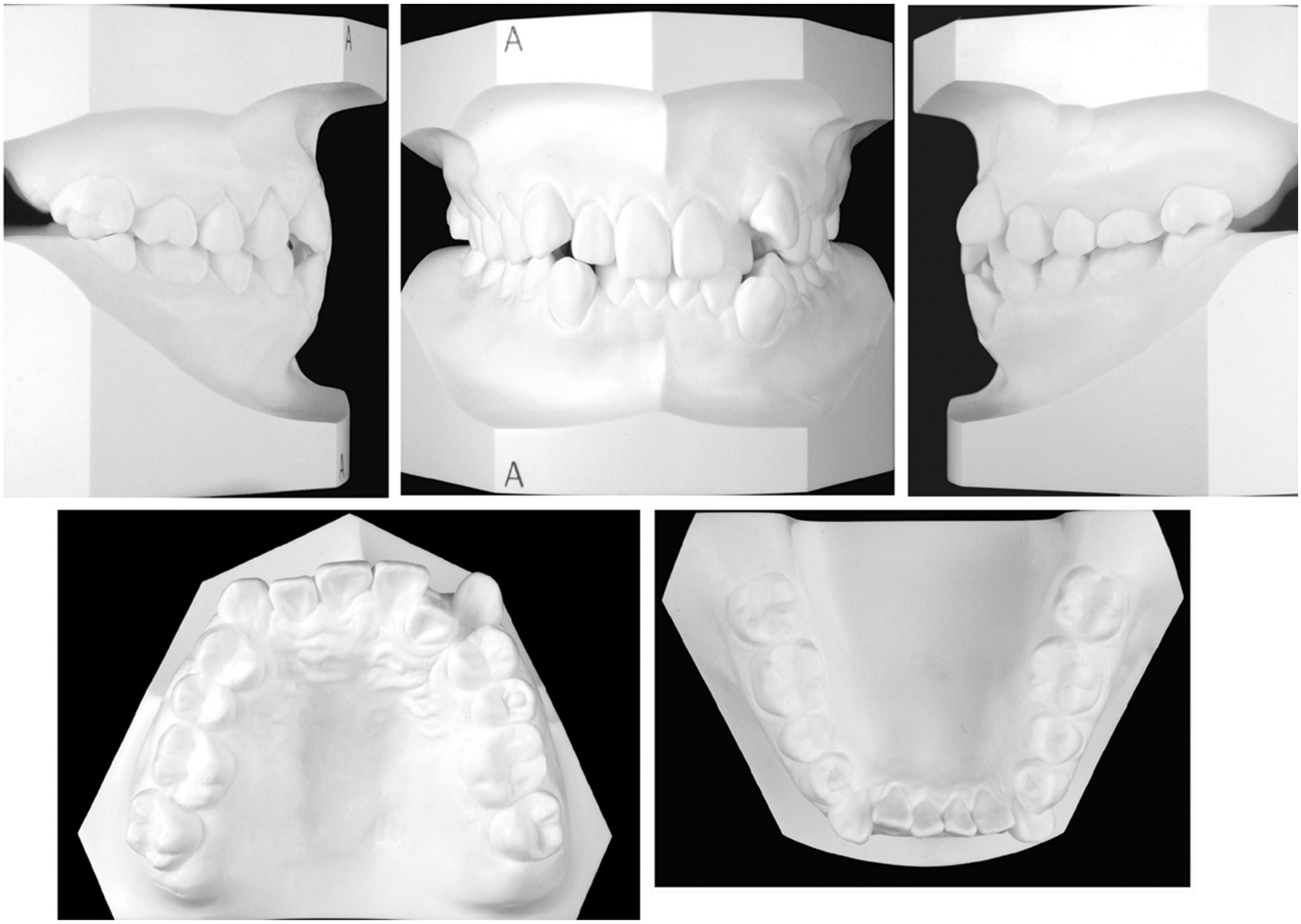

Fig. 4. Pretreatment dental casts.

After 3 years of retention and 2 years out of retention, there was a slight relapse of overbite and Class II relationship on the right side occlusion. All metal restorations of her teeth were changed to porcelain (Fig. 16).

3. Discussion

This multilingual bracket treatment showed good treatment results for an adult patient who was hesitant with orthodontic treatment for aesthetic reason. Although there is an increasing demand and desire to correct malocclusions in adult patients, the conventional orthodontic treatment using visible appliances might hinder patients from receiving treatment. Since Fujita introduced his multilingual bracket method, numerous case reports have been published on a variety of malocclusions corrected with this multilingual bracket system [4–7]. There is no other type of lingual bracket with a distinctive multifunctional structure that allows the insertion of two types of archwires simultaneously. Though we used previously only one archwire in either the occlusal or horizontal slots during treatment, recently, we use the DMA technique placing two archwires simultaneously into the two main bracket slots to achieve better quality of treatment results for correction of various kinds of malocclusions.

Fig. 5. Pretreatment panoramic radiograph.

The circumference of the dental arch of the lingual side is smaller than that of the labial side. As a result, the length of interbracket span of archwire is shorter than the conventional labial edgewise archwire (Fig. 17). If the same deformation is applied to the archwire, the wire on the lingual side would exert heavier force to the teeth. Thus, clinicians must select the size of the archwires carefully. In addition, mushroom archwires have complex shapes so more attention should be paid to control the force for tooth movement in lingual treatment.

The second difficulty in lingual treatment is over retroclination of anterior teeth. Lingual brackets are usually bonded at a lower position of the crown to avoid the bite of the opposing teeth. When the archwire is placed in the occlusal or horizontal slot, the application point of the orthodontic force to the tooth is just upon or inside than the position of the center of resistance. The depression

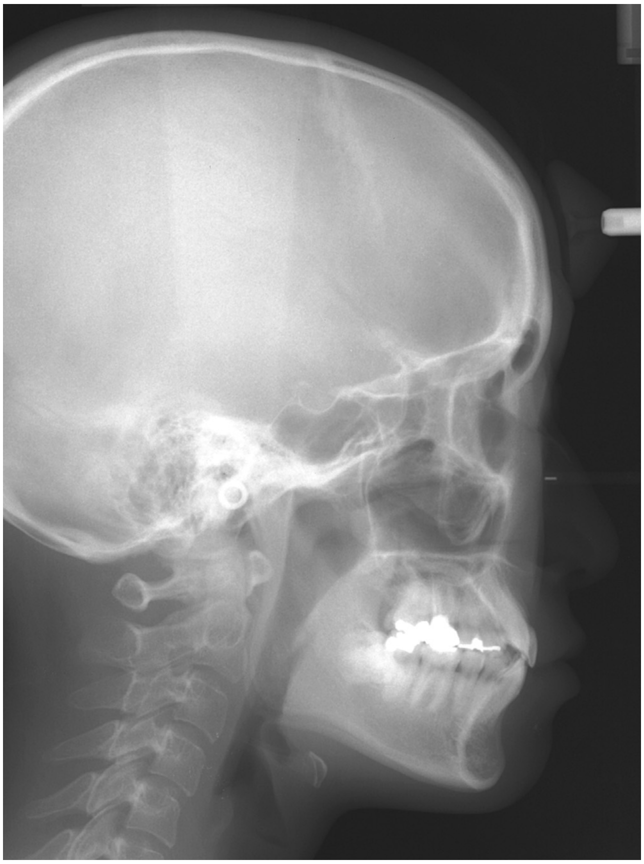

Fig. 6. Pretreatment lateral cephalometric radiograph.

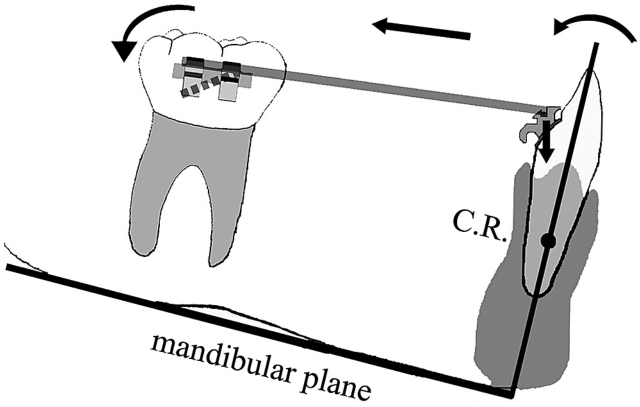

Fig. 7. The counterforce of depression enhances molar distal tipping, which reinforces the posterior anchorage. Dotted line indicates the tip back bend of the archwire.

force applied on the mandibular incisors may work to retrocline the crown of the anterior teeth, because the mean angle of the mandibular incisors is more acute than the maxillary (Fig. 7).

DMA technique would solve these treatment difficulties with its distinctive tooth movement. DMA technique uses a pair of different metallic property archwires: Ni-Ti in the occlusal slot and stainless steel archwires in the horizontal slot. The Ni-Ti wire applies light force to the malpositioned teeth during alignment phase while the stainless steel wire works to keep the other teeth in position for enforcement of dental anchorage. Less often, we bend vertical or horizontal loops in the archwire for the alignment of incisors. DMA has a great advantage to control tooth movement for achieving substantial treatment goals.

A 0.016 × 0.016-in or a 0.017 × 0.022-in closing mushroom archwire is placed into the horizontal slot, while a 0.018 × 0.018-in square mushroom archwire is placed into the occlusal slot. These two archwires create the labial crown torque for the anterior teeth (Fig. 18) and enable precise bodily movement while controlling the inclination of incisors. The inclination of mandibular incisors was controlled within the Japanese norm in this case.

The second premolar is selected for tooth extraction in labial edgewise treatment in the case of mild anterior teeth crowding and good facial profile [8–11]. If the first premolar tooth is chosen for extraction in such a case, it is believed that the mesial movement of molars is difficult to close the residual space. This patient had severe anterior crowding and hypodivergent type of face. We estimated that most of the premolar extraction space was consumed to correct the crowded anterior teeth. In the leveling phase of the lingual bracket treatment, the archwire was depressed and caused the uprighting of the molars, which reinforced anchorage. Closing the remaining extraction space after anterior teeth leveling would then be very difficult. For this reason, we chose the second premolar extraction for this treatment. In this case, reciprocal tooth movement was observed in the anterior and posterior teeth to close the little remaining space. Because the amount of mesial molar movement was very little, the FMA angle was stable and the facial vertical dimension was not affected by the second premolar extractions. Another important advantage of second premolar extraction for the patient is that the extraction black spaces are hidden, which is very critical for someone with high aesthetic demands.

Table 1
Cephalometric Analysis

Measurements (degrees)	Norm	SD	Pretreatment	Post-tretment
Skeletal pattern				
SNA	81.35	2.95	81.6	82.3
SNB	79.24	2.98	80.1	80.5
ANB	2.11	2.06	1.5	1.8
FMA	27.08	5.19	18.7	18.5
Gonial angle	121.62	5.96	108.5	108.9
OP/FH	10.75	4.04	11.0	10.6
Denture pattern				
U1-SN	104.34	5.75	105.6	100.0
L1-MP	93.02	6.17	100.6	95.0

Japanese standards are from Nagaoka and Kuwahara, 1993.

4. Conclusions

The invisible multilingual bracket treatment achieved favorable results to correct a severe Class I crowding with the adoption of DMA technique. Using two kinds of mushroom archwires placed simultaneously into two main slots of the lingual bracket, Fujita lingual brackets obtained adequate control of tooth movement. The invisible lingual bracket treatment leads to considerable satisfaction in orthodontic treatment for adult patients.

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Fig. 8. Progress intraoral photographs: initial treatment phase.

Fig. 9. Progress intraoral photographs: aligning maxillary incisors.

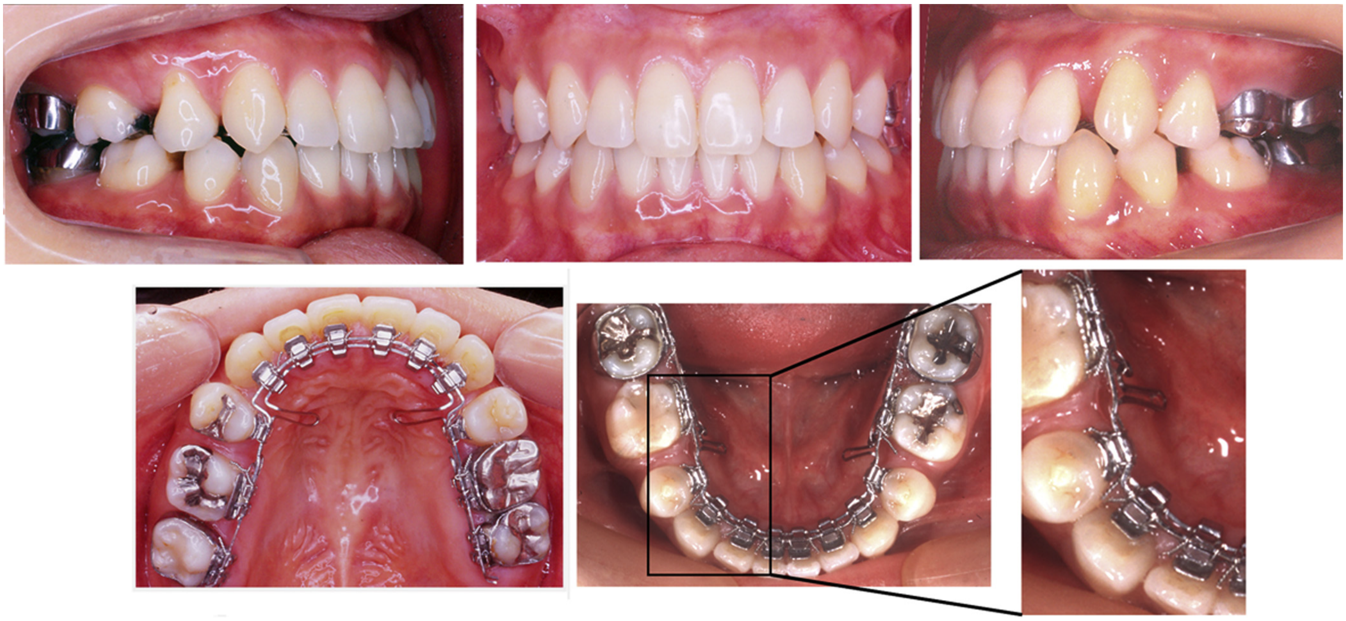

Fig. 10. Progress intraoral photographs: closing the extraction space. Two continuous archwires placed in both slots; one is a closing archwire in the horizontal slot, the other is a 0.018 × 0.018-in archwire to keep incisors upright and avoid tipping movement.

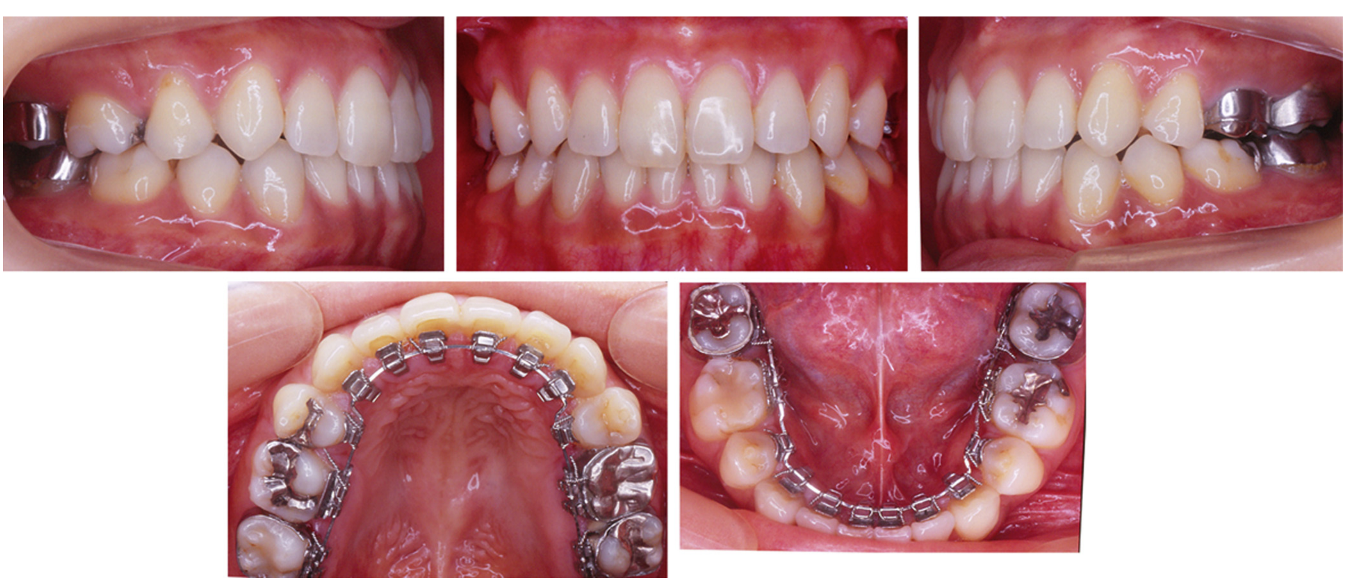

Fig. 11. Progress intraoral photographs: finishing phase.

Fig. 12. Posttreatment facial and intraoral photographs.

Fig. 13. Progress intraoral photographs and facial photographs.

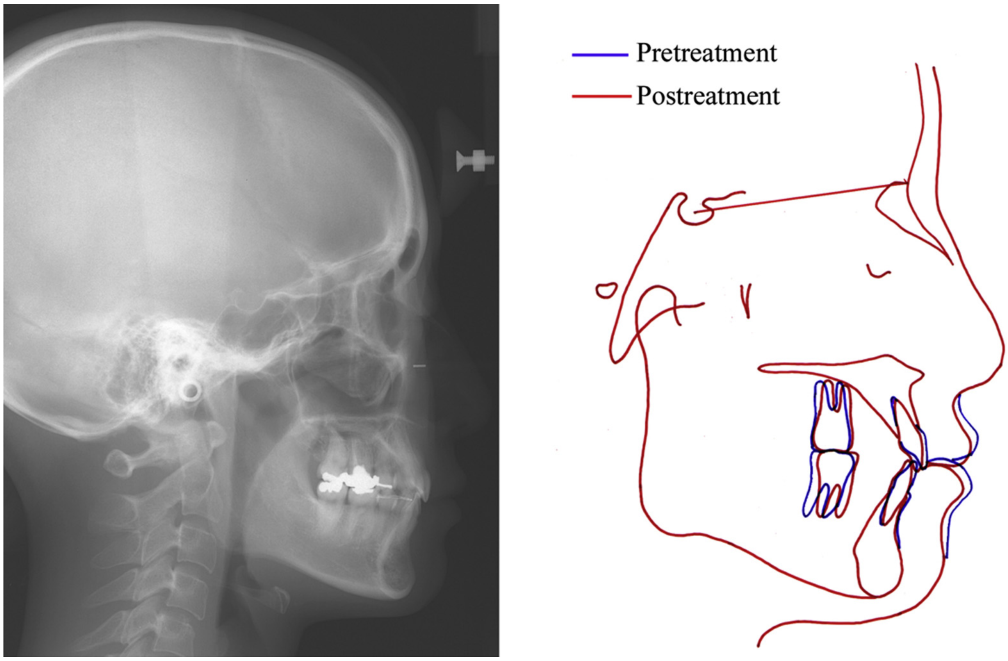

Fig. 14. Posttreatment lateral cephalometric radiograph and superimposed tracing.

Fig. 15. Posttreatment panoramic radiograph.

Fig. 16. Photographs 4 years after the end of treatment.

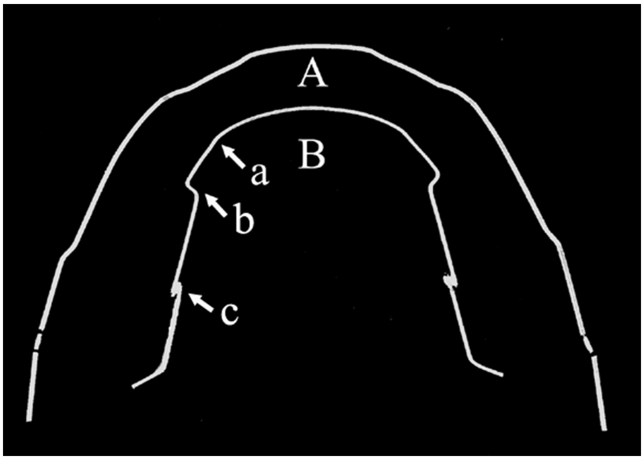

Fig. 17. A Conventional labial archwire. B Mushroom archwire. a: Canine offset; b: premolar crank; c: molar offset.

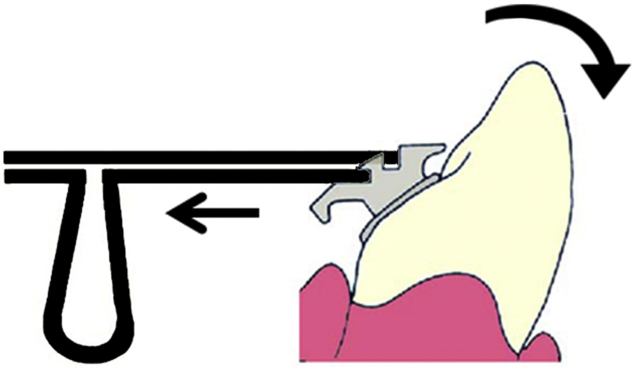

Fig. 18. A 0.016 X 0.016-in closing archwire placed into the lower position slot (horizontal slot) and a 0.018 X 0.018-in archwire placed into the upper position slot (occlusal slot) cause labial crown torque.