Application of all-NiTi mechanics combined with J-hook headgear in the treatment of an adult high angle Class I extraction case

Kunihiko Otsubo* Nahoko Imai Ladda Winarakwong****

Abstract

An adult high angle Class I with bimaxillary protrusion was treated by extraction of four first premolars. Application of a rectangular NiTi archwire from the beginning of the active treatment period, in combination with J-hook headgear, was used to facilitate the vertical control and reduce the dental and lip protrusion. Satisfactory treatment results were obtained after twenty-four months, with improvement in facial profile and smile appearance. The exclusively use of NiTi wires throughout the entire treatment, together with its advantages and disadvantages are discussed.

Key words: *high angle • J-hook headgear • nickel-titanium • protrusion*

Introduction

A high mandibular plane angle is a typical characteristic frequently found among the Japanese population[1, 2]. Adult patients with such vertical facial pattern, especially those with type II skeletal pattern, are not easily manipulated because most orthodontic force systems tend to extrude the posterior teeth, resulting in bite opening and backward rotation of the mandible. These consequences are unfavorable to the patient's facial morphology both in the anteroposterior relationship, e.g. exaggerated convex profile, and in the vertical dimension, which results in extrusion of upper incisors and increased gingival display. The relatively weak occlusal force usually associated with high angle subjects[3] makes the vertical control even more difficult.

Since 1971 when nickel-titanium (NiTi) wires were firstly used in orthodontics[4], the alloy has been continually improved and become more common in orthodontic use[5-8]. With its most benefits, a resilient rectangular NiTi wire allows simultaneous rotation, leveling, tipping, and torquing movements to be accomplished early in treatment[9]. Recently, we have successfully used super-elastic rectangular NiTi wires as initial wires in treating a wide range of malocclusions[10].

In the following case report, an application of a rectangular NiTi archwire from the beginning of the active treatment period, in combination with J-hook headgear, was used to facilitate the vertical control in successfully treating an adult patient who exhibited a Class II skeletal pattern with a high mandibular plane angle. The exclusively use of NiTi wires throughout the entire treatment, together with its advantages and disadvantages would also be discussed.

Diagnosis and Etiology

A 29y10m-old Japanese female patient came with the chief complaint of crowding and protrusion of her front teeth. She had a mouth-breathing habit, and often experienced sore throat due to sleeping with her mouth open. Her systemic background included allergic rhinitis and atopic dermatitis. Similar features of malocclusion were recognized in her family members; her mother also had protrusion and crowding, and her brother had severe crowding.

Clinical and functional examinations revealed a symmetric oval facial type and convex profile (Fig. 1). She had a gummy smile and incompetent lips at rest. The mentalis muscle was tense as she closed her lips. No sign or symptom of the temporomandibular joints (TMJ) was present. The border movements of the mandible were within normal limits in all directions. No discrepancy between the centric relation and centric occlusion was detected.

* Director and Head Orthodontist, Otsubo Orthodontic Clinic, Tokyo, Japan
** Orthodontist, Otsubo Orthodontic Clinic

Fig. 1 Pretreatment photographs

Intraorally, permanent dentition with clinical absent of the upper and partial impaction of the lower third molars was observed. The patient had her upper third molars extracted five years ago. The molar and canine relationships were Angle Class I. The upper dental midline was 2 mm deviated to the right, while the lower midline coincided with the facial midline. The overjet was 2.5 mm and 4.5 mm on the left and right, respectively. The overbite was 2 mm and 4.5 mm on the left and right, respectively. The maxillary right lateral incisor was lingually malposed and was in cross bite. Remarkable crowding was observed in the anterior region of both arches.

Model analysis revealed -7.5 mm and -7.0 mm tooth-arch discrepancies in the upper and lower arches, respectively. The mesio-distal width of all teeth was larger than one time S.D. of the Japanese norms. According to the Bolton's analysis, there was no discrepancy between the upper and lower dentitions.

The panoramic radiograph showed mild and moderate mesial inclination of the right and left mandibular third molars, respectively. No particular pathology was found in both skeletal and dental tissues (Fig. 2). Cephalometric analysis indicated a skeletal type II jaw relationship (Table 1) due to the retruded position of the mandible (ANB = 7°, SNA = 82.5°, SNB = 75.5°, SNPg = 74°), and a large mandibular pla ne angle (FMA = 43.0°, Gonial angle = 129.0°, Ramus inclination = -3.5°). The upper incisor inclination was in the normal range, but the lower incisors were labially proclined relative to the Frankfort horizontal (U1 to SN = 104.0°, FMIA = 45°). The relative positions of the upper and lower lips to the E-line were +4.5 mm and +9.5 mm, respectively.

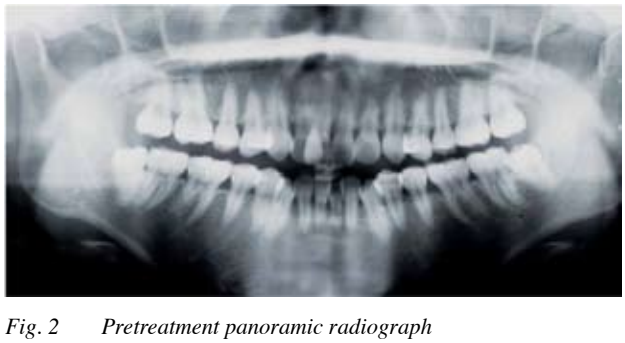

Fig. 2 Pretreatment panoramic radiograph

Table 1 Cephalometric Measurements

Cephalometric measurements	Norm	Pretreatment	Posttreatment
Facial angle	84.83	81.0	81.0
Convexity	7.58	16.5	16.0
A-B plane	-4.48	-7.5	-8.0
Mandibular plane	28.81	43.0	43.0
Y-axis	65.38	70.0	70.0
Occlusal plane	11.42	19.0 (17.5)	17.0
Interincisal angle	124.09	115.0	130.0
L1 to Occlusal plane	23.84	25.5 (24.5)	15.0
L1 to mandibular plane	96.33	92.0 (82.0)	79.0
U1 to A-P plane	8.92	14.0	9.0
FH to SN	6.19	7.0	7.0
SNA	82.32	82.5	82.0
SNB	78.90	75.5	75.0
ANB	3.39	7.0	7.0
U1 to N-P plane	11.74	20.0	9.0
U1 to FH plane	111.13	111.0	107.0
U1 to SN plane	104.54	104.0	100.0
Gonial angle	122.23	129.0	129.0
Ramus inclination	2.93	-3.5	-3.5
FMIA	54.60	45.0	58.0
APDI	80.61	81.0	80.0
ODI	72.34	71.5	71.0

The patient was diagnosed as a Class I malocclusion with a high mandibular angle, bimaxillary protrusion, and dental crowding. Considering her familial history, it was highly possible that there was a strong hereditary factor associated with the patient's arch dimensions and the tooth size. Her habitually lip opening suggested the weakened lip force, which was likely another cause of her malocclusion.

Treatment objectives

1. Improve the facial profile
2. Eliminate anterior tooth crowding
3. Maintain the anterior vertical dimension

Treatment alternatives

The patient was informed of treatment possibilities, with or without the four premolars extraction. It would be inevitable that the lower third molars be extracted if the patient wanted to keep her premolars. In addition, the improvement of her lip profile could not be expected without premolars extraction.

Since the protrusion of the anterior teeth was the patient's main concern, she agreed with the plan to extract all four first premolars in order to improve her facial profile and eliminate the crowding, but insisted to keep her lower third molars.

The definite treatment plan was therefore derived as follow:

1. Insert a transpalatal arch to gain stable anchorage, then refer for four first premolars extraction

2. Bond preadjusted edgewise appliances to the canines and buccal teeth to distalize the canines until enough spaces to level the incisors are acquired

3. Apply a J-hook headgear to the upper anterior teeth during incisors leveling to gain stable anchorage and intrude the upper incisors

4. Use vertical elastics to solidify the establishment of Class I occlusion and for final detailing

5. Use a full-coverage clear removable retainer for the upper arch, and a combination of Hawley type with a canine-to-canine fixed retainers for the lower arch.

Treatment progress

After a transpalatal arch was placed to the upper first molars, the four first premolars were extracted, an .018 X .025-inch slot preadjusted edgewise appliances with an oriental prescription (Kosaka, Tomy International, Japan) were bonded to the buccal segments of the upper and lower arches. Then .016 X .022-inch super-elastic NiTi sectional archwires were placed and canine distalization with elastic power chains was started (Fig. 3A).

Three months later, the brackets were bonded to the incisors except the upper right lateral incisor. An .016 X .022-inch super-elastic NiTi wire for the upper arch, and an .016-inch NiTi wire for the lower arch were inserted to level the anterior teeth (Fig. 3B). A 50 g preformed NiTi open coil spring was placed between the upper right canine and central incisor to gain space for the lateral incisor and for midline coincidence. In the fifth month, a bracket for lower incisors was bonded to the upper right lateral incisor, and the upper archwire was changed to an .016-inch NiTi wire.

At nine months after treatment start, the crossbite was corrected, and the upper archwire was changed to an .016 X .022-inch NiTi wire. A J-hook headgear with 200 g force was applied to the hooks crimped between the upper lateral incisors and canines on each side for upper anterior retraction and intrusion. A compensating curve and gable bends between the upper canines and the second premolars were added to the working wire by using a heat-bending machine (Fig. 4). The canines were also retracted with power chains at the same time. The transpalatal arch was removed after the completion of canine retraction around the twelfth month, while anterior retraction was continued with J-hook, occasionally in conjunction with short Class II elastics (Fig. 3C).

Fig. 3A-C During treatment photograph

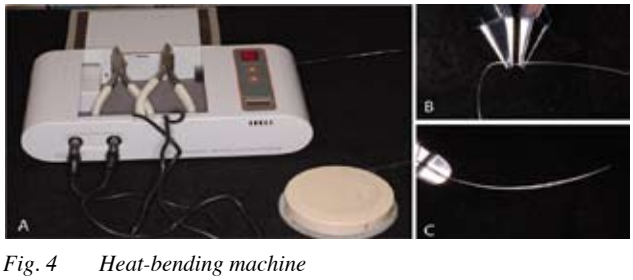

Fig. 4 Heat-bending machine

After nineteen months, a combination use of curved NiTi wires, J-hook headgear, and vertical elastics was performed. For this mechanics, .016 X .022-inch NiTi wires were used in both arches, with a compensating curve for the upper, and a reverse curve for the lower wires. Vertical elastics were applied on the left and the right sides at the distal of upper canines and the mesial of lower second premolars. Labial root torque was given to the upper right lateral incisor during the last few months of the treatment.

Twenty-four months after the start of active treatment, Class I occlusion with appropriate overbite and overjet was achieved. After removing all appliances, a full-coverage clear retainer for the upper arch, and a Hawley type with a fixed canine-to-canine retainers for the lower arch were delivered.

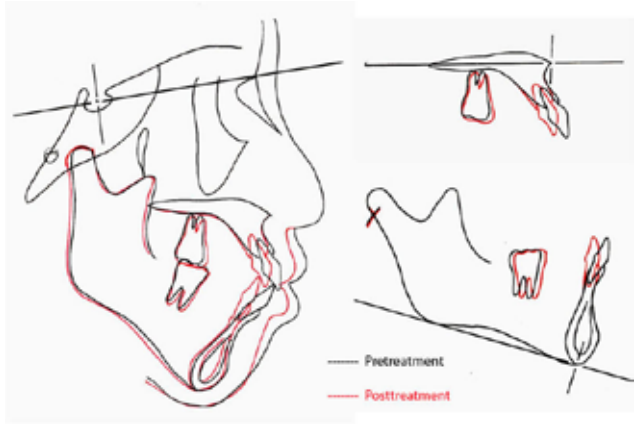

Fig. 6 Superimposition

Treatment results

The treatment had provided Class I molar and canine relationships with a 3.0 mm overjet, and a 3.5 mm overbite (Fig. 5). The mandibular plane angle was successfully maintained. The upper incisors were intruded while the favorable inclination was preserved (Fig. 6). The FMIA increased from 45˚ to 58˚, indicatin g an improvement of the lower incisors inclination. The relative relationships of the upper and lower lips to the E-line were reduced to 0 mm and 4.5 mm, respectively. The facial profile and smiling appearance were dramatically improved. Although some tension in the mentalis muscle was still visible, since the soft tissues change are known to come later, we expect an improvement in the future follow-ups.

Post treatment panoramic radiograph demonstrated root paralleling, and no root resorption was detected (Fig. 7). The lower third molars have not been problematic so far, and since the patients insisted to keep them, they were remained in place under periodic check-up. Physiological TMJ functions were preserved throughout the treatment period, without any symptom reported during the treatment.

Fig. 5 Post treatment photographs

Fig. 7 Post treatment panoramic radiograph

Discussion

The high mandibular plane angle is one of the craniofacial characteristics often found in Japanese population. The key to success in orthodontic treatment of such patients who also have retruded mandible, convex facial plane, and excessive gingival display, is to avoid the further opening of the mandible, and to intrude the incisors while anterior retraction was carried out.

The force system used in this case can be summarized as follows. First, the intrusion of upper incisors is carried out by using a super-elastic NiTi rectangular wire from the leveling stage, combined with the application of J-hook headgear. The upward-backward force exerted by the headgear acted as anterior support while the crowding was relieved without unnecessary proclination or extrusion of the incisors. As a result, the round-trip tooth movement was prevented, and the occlusal plane could be altered from the beginning. Furthermore, the method of applying anterior retraction force to the hooks crimped to the archwire allowed us to continue canine distalization by sliding mechanics simultaneously. This, in turn, effectively shortened the overall treatment period. During the final stage of treatment, the same working NiTi rectangular archwires in conjunction with vertical elastics in the canine regions were employed to tip back the molars and refine the posterior tooth interdigitation. With a compensating curve for the upper and a reverse curve for the lower arches embedded into the wires, the appliances gave a similar force system as the multi-edgewise archwire (MEAW) mechanics[11]. Additionally, continual use of the J-hook headgear in the mean time could prevent the elongation of the incisors.

It can be stated that one of the most remarkable advantages of the NiTi wire is the low magnitude of force, and thus, less potential to cause root damage [12]. Although the intrusion of upper incisors increases the risk of apical root resorption[13], the present case demonstrated only minimal root resorption despite the considerable amount of the upper incisors intrusion that had been accomplished. Moreover, the continuous arch mechanics had been delayed in an effort to limit the duration of force applying to the incisors, and to avoid unnecessary or round-trip tooth movement. Therefore, leveling of the crowded incisors had not been started until sufficient spaces were obtained from canine distalization. The delay, however, did not prolong the total treatment time because the resilient rectangular NiTi wire allows the clinician to level, intrude and retract the incisors at the same time.

Generally, NiTi wires are mostly used only during the leveling stage due to its restricted form-ability, which makes it difficult to bend[14]. In order to fully gain the benefit from the super-elastic property of NiTi wires, we used a heat-bending machine to facilitate wire bending, as well as to strengthen the wires and make them suitable for the sliding mechanics [15, 16]. As shown in this case, several kinds of bends and wire hardening by heat treatment could be performed in the same manner as other manually bendable wires, demonstrating that NiTi wires can be useful throughout the entire process of treatment. However, the third order bends sometimes provide insufficient torque level, and other measures maybe required. For example, we had used a lower incisor bracket for the lingually retroclined right lateral incisor to assure effective labial root torque. In some other occasions, a stainless steel wire would be more preferable when critical torque control is necessary.

The use of extraoral anchorage in this case had provided a maximum control of the upper molars, indicating the patient's excellent cooperation. Other alternatives such as skeletal anchorage or miniscrew/ mini implant anchorage[17] may be indicated if the patient's compliance could not be expected.

In summary, combined usage of NiTi rectangular wires and J-hook headgear is an efficient method in treating such skeletal type II high angle with gummy smile cases.

References

1. Miura F, Inoue N and Suzuki K. Cephalometric standards for Japanese according to the Steiner analysis. ***Am J Orthod*** 1965;51:288-95.

2. Iwasawa T, Moro T and Nakamura K. Tweed triangle and soft-tissue consideration of japanese with normal occlusion and good facial profile. ***Am J Orthod*** 1977;72:119-27.
3. Braun S, Bantleon HP, Hnat WP, Freudenthaler JW, Marcotte MR and Johnson BE. A study of bite force, part 2: Relationship to various cephalometric measurements. ***Angle Orthod*** 1995; 65:373-7.
4. Andreasen GF and Hilleman TB. An evaluation of 55 cobalt substituted Nitinol wire for use in orthodontics. ***J Am Dent Assoc*** 1971;82:1373-5.
5. Shima Y, Otsubo K, Yoneyama T and Soma K. Bending properties of hollow super-elastic Ti-Ni alloy wires and compound wires with other wires inserted. ***J Mater Sci Mater Med*** 2002;13:169-73.
6. Miura F, Mogi M, Ohura Y and Hamanaka H. The super-elastic property of the Japanese NiTi alloy wire for use in orthodontics. ***Am J Orthod Dentofac Orthop*** 1986;90:1-10.
7. Waters NE. Superelastic nickel-titanium wires. ***Am J Orthod Dentofac Orthop*** 1992;19:319-22.
8. Kusy RP. A review of contemporary archwires: Their properties and characteristics. ***Angle Orthod*** 1997;67:197-207.
9. Miura F, Mogi M and Okamoto Y. New application of superelastic NiTi rectangular wire. ***J Clin Orthod*** 1990;24: 544-8.
10. Kanno Z, Enokida M, Otsubo K and Soma K. Efficient anterior intrusion and posterior uprighting accomplish excellent treatment outcomes in bi-alveolar protrusion cases The 65th Annual Meeting of the Japanese Orthodontic Society. Fukuoka, Japan; 2006.
11. Kim YH. Anterior openbite and its treatment with multiloop edgewise archwire. ***Angle Orthod*** 1987;57:290-321.
12. Owman-Moll P. Orthodontic tooth movement and root resorption with special reference to force magnitude and duration. A clinical and histological investigation in adolescents. ***Swed Dent J Suppl*** 1995;105:1-45.
13. Dermaut LR and Demunck A. Apical root resorption of upper incisors caused by intrusive tooth movement - a radiographic study. ***Am J Orthod Dentofac Orthop*** 1986;90:321-6.
14. Drake SR, Wayne DM, Powers JM and Asgar K. Mechanical properties of orthodontic wires in tension, bending, and torsion. ***Am J Orthod*** 1982;82:206-10.
15. Otsubo K. Changes in force level of Ti-Ni alloy wires in the experimental oral environment. ***J Jpn Orthod Soc*** 1994;53: 555-61.
16. Otsubo K, Yoneyama T, Hamanaka H and Soma K. Influence of temperature on the force level of a super-elastic NiTi alloy wire under strain. ***J Jpn Soc Dent Mater Devices*** 1993;12: 521-7.
17. Choi NC, Park YC, Lee HA and Lee KJ. Treatment of class II protrusion with severe crowding using indirect miniscrew anchorage. ***Angle Orthod*** 2007;77:1109-18.