CASE REPORT

Lingual Segmented Treatment in the Maxillary Arch

YUJI YOSHIZAWA, DDS, DDSC
KATSUJI TANAKA, DDS, DDSC

In lingual orthodontics, it is difficult to construct and place a properly shaped continuous archwire with loops and springs for maxillary anterior retraction. Segmentation of the maxillary archwire into anterior and buccal segments has been shown to provide a more desirable force distribution around the arch,[1,2] but a utility-wire approach in lingual therapy would complicate wire manipulation and cause patient discomfort.

Davis and Usiskin reported a reduction in overjet following canine retraction with extraoral forces applied to direct-bonded tubes.[3] This finding prompted us to try a similar approach to lingual treatment of the maxillary arch. The present article will introduce our segmented approach with a typical case.

Diagnosis and Treatment Plan

A 20-year-old female patient presented with a Class II subdivision malocclusion, moderate crowding, a protrusive lower lip, and a mesofacial pattern (Fig. 1). The maxillary incisors were protrusive and moderately crowded. The mandibular incisors were slightly procumbent and crowded.

TABLE 1
CEPHALOMETRIC ANALYSIS (°)

	Before Treatment	After Treatment	Norm	S.D.
SNA	80.0	79.0	81.30	2.69
SNB	74.0	73.0	78.75	2.71
ANB	6.0	6.0	2.56	1.08
FMA	23.0	24.0	26.34	4.07
IMPA	106.0	105.0	96.77	6.41
FMIA	51.0	51.0	56.90	6.39
1-FH	111.5	98.5	112.08	4.23
Interincisal	120.0	132.5	123.54	5.46
FH-Occlusal Plane	10.5	14.0	9.90	3.84

Treatment objectives, based on the results of cephalometric (Table 1) and study cast analyses, were to:

1. Achieve maxillary incisor retraction through controlled tipping and maximum anchorage.
2. Correct the dental Class II malocclusion.
3. Eliminate crowding in both arches.

Lingual therapy was planned to achieve these goals.

Dr. Yoshizawa

Dr. Tanaka

Dr. Yoshizawa is in the private practice of orthodontics at Asuka Orthodontic Office, Nemoto Building #3 4F, 1-2-8 Asahicho, Kashiwa, Chiba 277-0852, Japan. Dr. Tanaka is in the private practice of orthodontics in Ogaki City, Gifu, Japan.

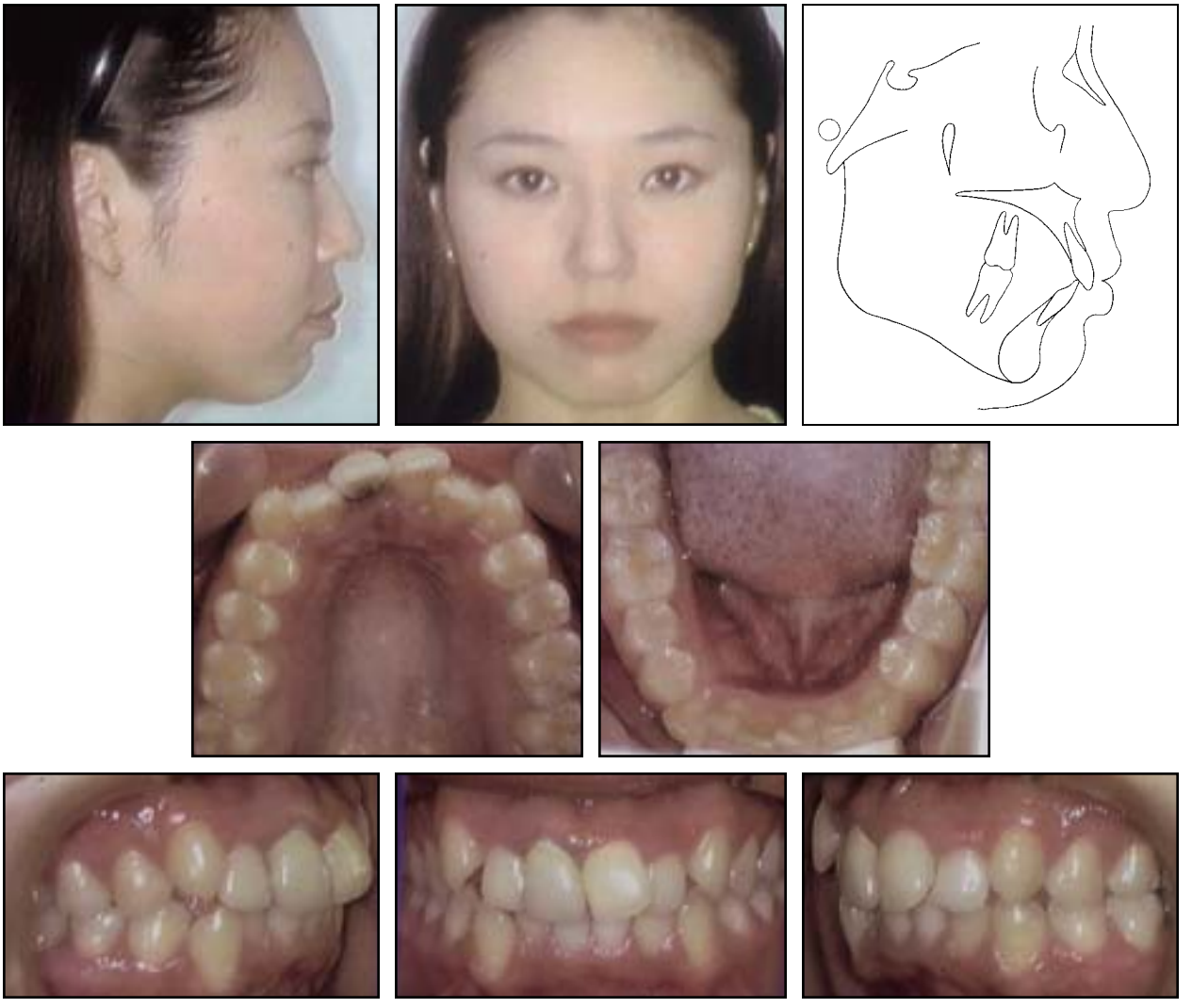

Fig. 1 20-year-old female with Class II subdivision malocclusion before treatment.

Treatment Progress

The two maxillary first premolars and mandibular right second premolar were extracted to provide space for alignment and retraction of the incisors. Brackets were placed on all teeth except the maxillary anterior segment. After two months of mandibular leveling, an acrylic cap was worn for a month, in combination with a high-pull J-hook headgear, to open the bite enough for placement of lingual brackets on the maxillary anterior teeth while maintaining posterior occlusal contact.[4]

After both arches were level, maxillary canine retraction was initiated. The maxillary incisors drifted distally through controlled tipping for five months while the canines were retracted with closed loops (Fig. 2). In the meantime, bilateral Class II elastics were used to move the mandibular right first molar mesially, producing small spaces mesial to the canines (Fig. 3).

A continuous .016" Tynil-

loy* archwire was then overlaid on the anterior and buccal segments for further canine retraction (Fig. 3). Over the next few months, without the use of extraoral traction, no distal migration of the maxillary incisors was observed (Fig. 4).

The .016" Tynilloy overlay, with a line of intrusive force passing labially to the center of resistance of the incisors,[5] induced distal incisor root movement, which helped maintain an adequate moment-to-force ratio for controlled tipping. Elastomeric chains attached from the canines to the lateral incisors delivered forces closer to the center of resistance, thus minimizing the moment generated by the retraction force (Fig. 5). Although it took us several months to optimize the overlay technique, incisor retraction was accomplished in nine months with the same degree of controlled tipping as occurred during the spontaneous distal migration of the incisors (Fig. 6).

The overlaid sectional archwires remained in place for the last two months of detailing. Total active treatment time was 26 months.

Treatment Results

The patient's overjet and overbite were corrected, and the lower lip position was improved (Fig. 7). Correction of the maxillary incisor position was achieved through controlled tipping and maximum anchorage (Fig. 8). The slight clockwise rotation of the mandible may be attributed to the extrusive effect of the Class II elastics on the mandibular posterior teeth.

Discussion

There are several advantages of this segmented approach to lingual treatment of the maxillary arch. First, unlike a continuous archwire, it requires no complicated wire bending. Furthermore, when the maxillary arch is divided into anterior and buccal segments, no anterior moment is delivered to the maxillary incisors; undesirable extrusive forces are avoided, because the mandibular incisors merely occlude on the maxillary incisor bracket biteplanes.

Intrusive forces applied to the anterior segment are always reciprocated by extrusive posterior forces, which will adversely affect the axial inclinations of the posterior teeth.[6] These vertical forces are even greater in lingual orthodontics, due to the higher load/deflection ratio from the reduced distance between the canine and second premolar brackets.[7] Therefore, when a continuous archwire is used, it becomes necessary to connect the buccal segments with a transpalatal bar and have the patient wear a high-pull headgear to prevent the posterior teeth from extruding. With the segmented treatment approach, a transpalatal bar alone is sufficient to resist the level of extrusive force generated in the buccal segments.

It is difficult even in labial treatment to achieve controlled retraction of the maxillary incisors with a continuous archwire, due to vertical side effects and an inadequate moment-to-force ratio.[8,9] For example, if 100g of horizontal force is used for maxillary incisor retraction, a moment of 500-700g-mm is needed to achieve the required moment-to-force ratio of 5-7 for controlled tipping of the incisors.[6] Incisor retraction with a continuous archwire also necessitates the placement of distal root torque as a couple on the maxillary incisors. When a continuous archwire is activated for distal incisor root movement, the alpha moment becomes greater than the beta moment, resulting in a net extrusive force on the incisors.[1,10] In lingual treatment, this extrusive force is increased, with the mandibular incisal edges acting as a fulcrum to induce a significant mesial root movement of the incisors. We formerly had to use an acrylic cap in combination with a high-pull J-hook headgear to prevent this unwanted effect.[11] As shown here, the acrylic cap is still useful in deep-bite patients because it permits early placement of lingual brackets on the maxillary anterior teeth without causing posterior disclusion.

Closed-loop mechanics, using a formable wire with a low load/deflection ratio (such as TMA**) is more effective than sliding mechanics, which has a lower moment-to-force ratio and thus tends to produce uncontrolled tipping. The T-loop seems to be the best design for increasing the moment-to-force

Fig. 2 A. Beginning of canine retraction. B. After two months of canine retraction. C. After five months of canine retraction. Arrows indicate divisions of archwire segments.

Fig. 3 Further canine retraction with .016" Tynilloy overlay archwire.

ratio and reducing the load/deflection rate.[12] However, it is time-consuming to bend a TMA wire into a complicated T-loop configuration and insert it into maxillary lingual brackets. Our bending tests of .016" Tynilloy wire found that its permanent deformation reached stability after 30 minutes, and that the average amount of force required to bend the wire to 30° of deflection at 30 minutes was 86g per side at 25°C—about 10% lower than the force of the wire at 37°C (95g, according to the manufacturer). A force of 95g from a wire placed in the incisal slots of the lingual incisor brackets will produce 285g-mm of anti-tipping moment, which falls within the range of 240-360g-mm required to control tipping of the incisors during their retraction. This indicates that Tynilloy wire is suitable for use as an overlay in segmented lingual treatment.

The force of an elastomeric chain decays rapidly, with 30% of the initial force lost in the first hour and complete deactivation within three weeks.[13] Therefore, the distal root movement produced by the intrusive force of the Tynilloy overlay would be expected to occur in the latter part of each treatment interval. At the same time, however, the earlier spontaneous distal migration of the maxillary incisors helps preserve anchorage. In fact, superimpositions of the pa-

*Sankin Industrial Corporation, 1382-11 Shimoishiue, Otawara City, Tochigi 324-0036, Japan.

Fig. 4 After four months of canine retraction, with no spontaneous distal migration of incisors.

Fig. 5 After one month of en masse incisor retraction with elastomeric chains. Canine portions of .016" Tynilloy wire were covered with vinyl tubes to increase angle O.

tient presented here, before and after the distal incisor migration, show controlled tipping of the incisors and little loss of anchorage (Fig. 8).

Studies of the lip bumper have shown that it achieves its effect through variations in resting and functional lip pressures as the lip muscles adapt to changes in position.[14-17] On the other hand, many clinicians have reported that the teeth will spontaneously drift distally when adequate space is provided.[18,19] Moss and Picton concluded that this drift is related primarily to the transseptal fiber system.[20,21] In our patients, the spontaneous distal migration of the incisors following mechanical canine re-

Fig. 6 After nine months of en masse incisor movement.

traction seems to be effected by both lip pressure and "driftodontics",[22] with the maxillary incisors tipping around their root apices as they migrate distally. Therefore, a patient requiring controlled tipping of the incisors for maxillary anterior retraction would be a good candidate for this segmented lingual treatment approach.

REFERENCES

1. Burstone, C.J.: The segmented arch approach to space closure, Am. J. Orthod. 82:361-378, 1982.
2. Burstone, C.J.: Rationale of the segmented arch, Am. J. Orthod. 48:805-822, 1963.
3. Davis, H.D. and Usiskin, L.A.: Retraction of canines with axial control using extra-oral traction, Br. J. Orthod. 8:23-30, 1981.
4. Yoshizawa, Y.; Tanaka, K.; Mine, O.; and Hayashi, Y.: Orthodontic treatment with lingual appliance: Simplification of maxillary treatment system, J. Orthod. Pract. 13:67-85, 1997.
5. Pedersen, E.; Isidor, F.; Gjessing, P.; and Andersen, K.: Location of centers of resistance for maxillary anterior teeth, measured on human autopsy material, Eur. J. Orthod. 13:452-458, 1991.
6. Burstone, C.J.; Steenbergen, E.; and Hanley, K.J.: *Modern Edgewise Mechanics & The Segmented Arch Technique*, Ormco Corporation, Glendora, CA, 1995, p. 50.
7. Mulligan, T.: *Common Sense Mechanics*, CSM Publishing Co., Phoenix, 1982, p. 41.
8. Martina, R. and Paduano, S.: The translation arch, J. Clin. Orthod. 31:750-753, 1997.
9. Gjessing, P.: A universal retraction spring, J. Clin. Orthod. 28:222-242, 1994.
10. Burstone, C.J. and Koenig, H.A.: Creative wire bending: The force system from step and V bends, Am. J. Orthod. 93:59-67, 1988.
11. Yoshizawa, Y.; Tanaka, K.; and Mine, O.: Orthodontic treatment with lingual appliance: Dynamical study, J. Orthod. Pract. 12:51-66, 1996.
12. Staggers, J.A. and Germane, N.: Clinical considerations in the use of retraction mechanics, J. Clin. Orthod. 25:364-369, 1991.
13. Kosaka, H.: 2nd stage of Kosaka straight wire system, J. Orthod. Pract. 11:29-40, 1995.
14. Ghafari, J.A.: A lip-activated appliance in early orthodontic treatment, J. Am. Dent. Assoc. 111:771-774, 1985.
15. Bergersen, E.O.: A cephalometric study of the clinical use of the mandibular lip bumper, Am. J. Orthod. 61:578-602, 1972.
16. Soo, N.D. and Moore, R.N.: A technique for measurement of intraoral lip pressures with lip bumper therapy, Am. J. Orthod. 99:409-417, 1991.
17. McNulty, E.C.; Lear, C.S.C.; and Moorrees, C.F.A.: Variability in lip adaptation to changes in incisor position, J. Dent. Res. 47:537-547, 1968.
18. Creekmore, T.D.: Teeth want to be straight, J. Clin. Orthod. 16:745-764, 1982.
19. Miyajima, K. and Nakamura, S.: Distalization with "Driftodontics", J. Clin. Orthod. 28:393-394, 1994.
20. Moss, J.P. and Picton, D.C.A.: The causes of migration of teeth, Trans. 3rd Inter. Orthod. Cong., Crosby, Lockwood & Staples, London, 1973, pp. 536-543.
21. Moss, J.P. and Picton, D.C.A.: Short-term changes in the mesiodistal position of teeth following removal of approximal contacts in the monkey Macaca fascicularis, Arch. Oral. Biol. 27:273-278, 1982.
22. Alexander, R.G.: *The Alexander Discipline*, Ormco Corporation, Glendora, CA, 1986, p. 211.

**Registered trademark of Ormco/"A" Company, 1717 W. Collins Ave., Orange, CA 92867.

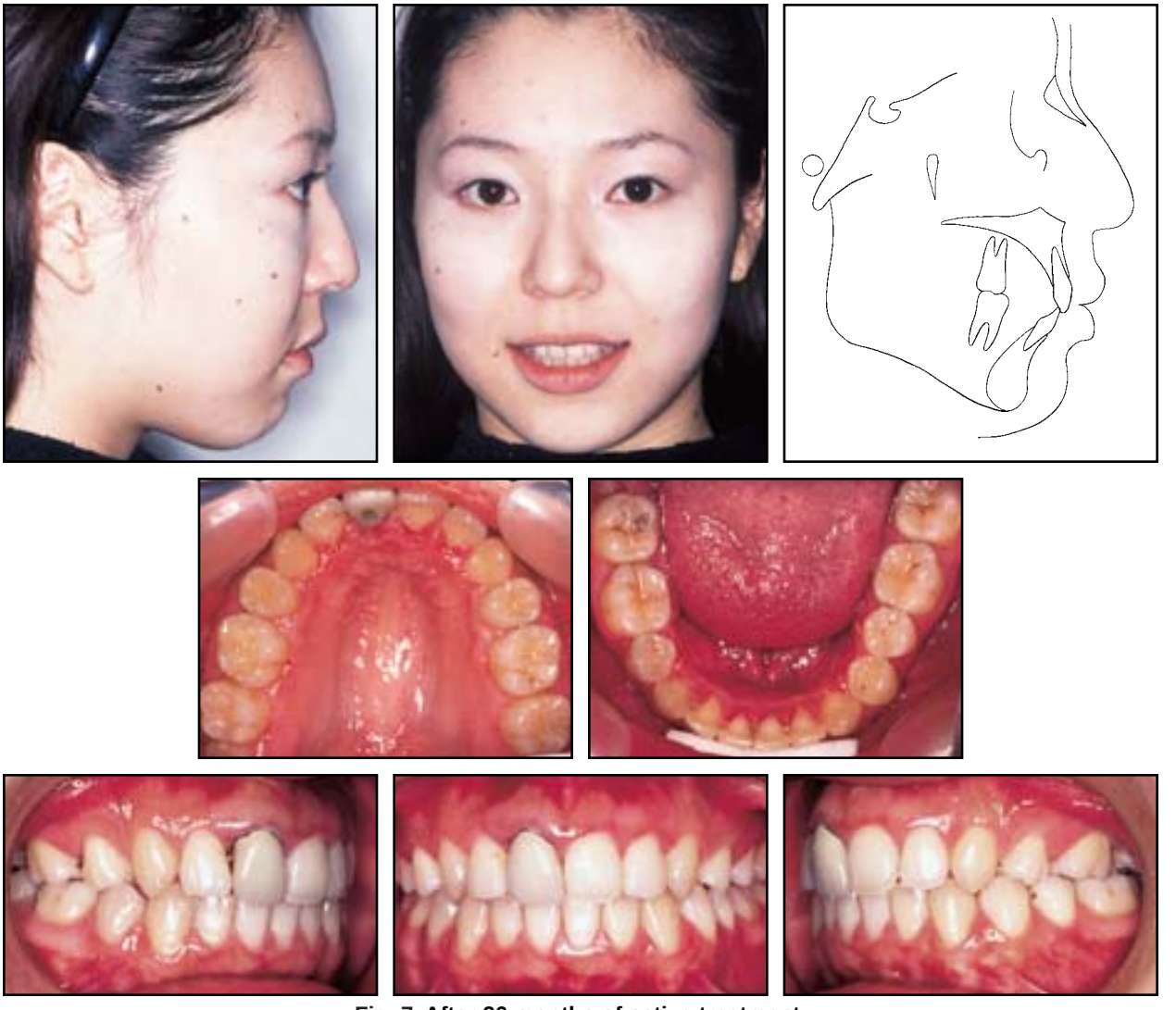

Fig. 7 After 26 months of active treatment.

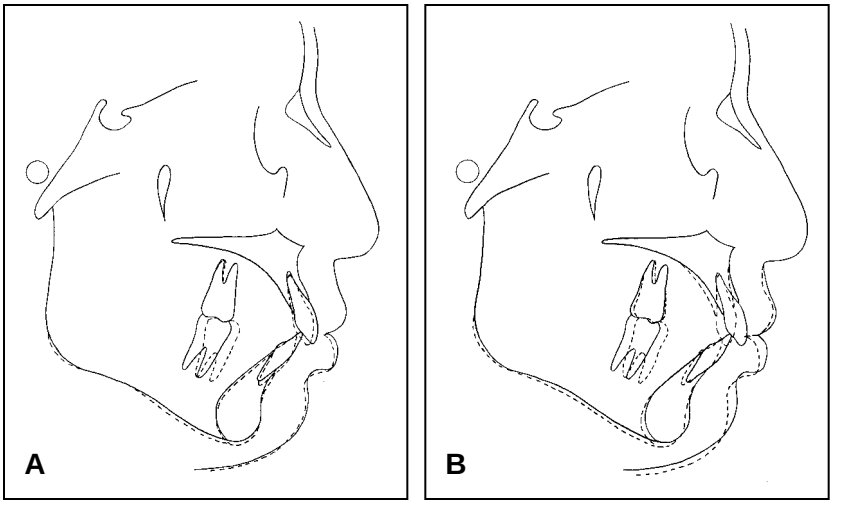

Fig. 8 A. Superimposition of cephalometric tracings on SN before treatment (solid line) and after spontaneous distal migration of maxillary incisors (dashed line). B. Superimposition of cephalometric tracings on SN before (solid line) and after (dashed line) active treatment.