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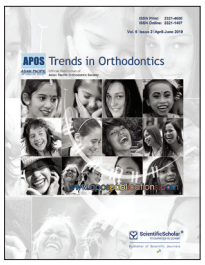

Case Report

Management of moderate crowding by two-arch distalization using passive self-ligating lingual brackets, in-house digital indirect bonding, and mini-screw anchorage: A case report

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ABSTRACT

This case report presents the management of an adult patient with moderate crowding in both arches and anterior crossbite with passive self-ligating lingual brackets. The orthodontic setup and bracket positioning was done digitally with an in-house approach. Virtual setup and bracket placement was performed on Autolign software (Diorco, Gyeonggi-do, Korea). The indirect bonding trays were vacuum-formed on printed malocclusion models with resin brackets. Two palatal and two buccal shelf miniscrews were used for two-arch distalization to correct proclined incisors and anterior open bite after leveling and alignment stage. After 12-month treatment, normal overbite,overjet and well-aligned dentition were achieved without premolar extraction. The incisors were uprighted slightly and the protrusive lower lip was retracted with improvement of facial harmony. One-year retention records confirmed that the outcome was stable. In-house digital setup and bracket placement could be a cost-effective approach for indirect lingual bracket bonding. Two-arch distalization with miniscrew anchorage may have the possibility of managing moderate crowding cases without premolar extraction or interproximal stripping.

Keywords: Lingual orthodontics, Passive self-ligating brackets, Indirect bonding, Distalization, Digital orthodontic setup

INTRODUCTION

Today, despite the outbreak of clear aligner treatment, lingual orthodontics is still a viable esthetic treatment alternative with the advantage of truly invisible and non-compliant appliances. There have been many published lingual orthodontic case reports recently but most of them were treated by conventionally ligating[1-4] or active self-ligating lingual brackets.[5,6] At present, there are only few articles[7,8] and no case report about passive self-ligating lingual brackets in the literature.

In mild-to-moderate crowding cases, molar distalization is a possible option of non-extraction space creation besides interproximal stripping and arch expansion. With the help of skeletal anchorage, molar distalization could be more effective and less dependent on patient compliance. In the literature, most published case reports performed distalization in one arch, only few two-arch distalization cases are available.[9,10]

The accuracy of bracket position has a major impact on the quality of lingual orthodontic treatment result.[11,12] At present, indirect lingual bracket placement is usually done manually

through complicated laboratory procedures or digitally with closed source software and the laboratory fee is usually high. There is only one case report performing digital in-house indirect lingual bracket positioning in which only the preliminary bracket bonding stage was reported without the final treatment result.[13]

This case report presents the management of an adult patient with moderate crowding in both arches and anterior crossbite with passive self-ligating lingual brackets. Indirect lingual bracket placement was done digitally by an in-house approach. Third molars were extracted and miniscrew-assisted distalization was performed in both arches to correct proclined incisors and anterior open bite after leveling and alignment stage.

DIAGNOSIS AND ETIOLOGY

A 28-year-old female patient visited the clinic with the chief complaint of crowding and anterior crossbite. An invisible appliance was strongly requested by the patient for esthetic reason. The lateral profile examination revealed a convex profile with slightly protrusive lower lip [Figure 1]. There was frontal mild asymmetry with the left slightly larger than the right and chin deviation to the left. No symptom of temporomandibular joint was detected.

Intraorally, the patient had mild Class III canine and molar relationship on both sides with crossbite on lateral incisors and edge-to-edge bite on central incisors [Figure 2]. The arch length discrepancies were 5.2 mm in the upper arch and 3.8 mm in the lower arch. The lower dental midline was coincident with facial midline and the upper dental midline shifted 0.5 mm to the right. Both upper and lower arch forms were square. There was lateral open bite in the canine region.

The panoramic radiograph indicated that mandibular right third molar was absent, and all other teeth were present with healthy periodontal condition [Figure 3]. The lateral cephalometric analysis showed a skeletal Class I jaw relationship with a normal mandibular plane angle (A point nasion B point (ANB), 2.8°; Frankfort mandibular plane angle (FMA), 26.4°) [Table 1]. The upper incisors had normal proclination and the lower incisors were proclined (U1-SN, 103.3°; Incisor mandibular plane angle (IMPA), 97.1°). Her upper lip was behind the E-line (UL/E-line,-1.0 mm) and her lower lip was in front of the E-line (LL/E-line, 1.2 mm).

Treatment objectives

The treatment objectives included leveling and alignment of both dental arches without proclining the incisors, retraction of lower incisors to achieve normal overjet and overbite, achievement of Class I canine and molar relationship on both sides, correction of dental midline deviation, and retraction of the lower lip to improve balance of lower face.

Treatment alternatives

Two potential treatment options were considered for this patient according to the treatment objectives. The first option was non-extraction treatment with total distalization in both arches to create space for tooth alignment and retract lower

Figure 1: Pre-treatment facial and intraoral photographs.

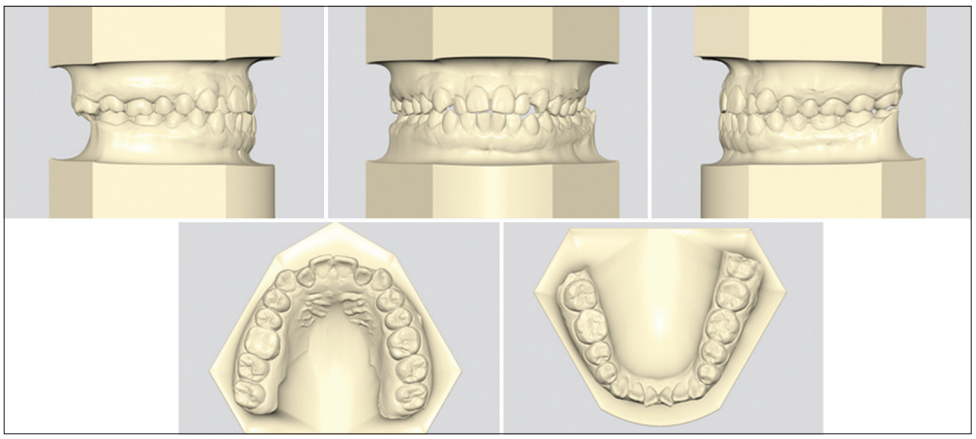

Figure 2: Pre-treatment study models.

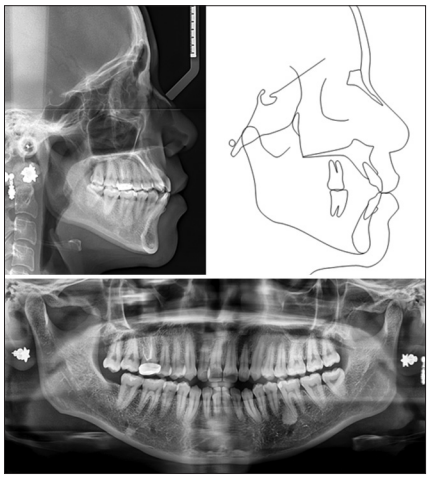

Figure 3: Pre-treatment radiographs and tracing.

incisors. The distalizing amount in the lower arch would be more than that in the upper arch. The second option was 4 second premolar extraction in combination with Class III elastic to achieve dental Class I relationship and normal overjet. The lips would be retracted more with the second option than with the first option. Because the patient wanted her profile not to be flattened and desired a non-extraction (except third molars) approach, the first option was chosen with passive self-ligating lingual brackets.

Treatment progress

After intraoral scanning of both the dental arches and occlusion, the standard tessellation language (STL) format files were exported and imported into Autolign software (Diorco, Gyeonggi-do, Korea). On the software, the teeth and gingiva were virtually segmented and the virtual setup was done according to the treatment objectives. Then, the virtual lingual brackets were placed with the bracket slots aligned on a straight lingual archwire in each arch, the shape and size of the lingual archwires were adjusted to minimize the spaces between the bracket bases and the lingual tooth surfaces. The archwire shapes were exported as printable files to serve as templates for wire bending. After confirming the bracket position, all the teeth were moved back to the original malocclusion together with the lingual brackets. The exported STL files of initial malocclusion models with brackets from the Autolign software were imported into Meshmixer software (Autodesk, California, USA) to fill the gaps between bracket bases and the lingual tooth surfaces [Figure 4].

The final STL files were imported into Lychee Slicer software (Mango 3-dimensionally [3D], Bordeaux, France) for support

Table 1: Cephalometric measurements.

	Pretreatment	Posttreatment	1-y retention
Skeletal			
SNA (°)	79.7	79.8	79.9
SNB (°)	76.9	76.8	76.9
ANB (°)	2.8	3.0	3.0
FMA (°)	26.4	26.7	26.6
Dental			
U1-SN (°)	103.3	100.5	100.3
U1-NA (°)	23.6	20.7	20.8
U1-NA (mm)	5.0	5.6	5.5
L1-MP (°)	97.1	94.4	94.5
L1-NB (°)	32.6	29.1	29.2
L1-NB (mm)	8.3	8.0	8.0
U1-L1 (°)	121.0	127.3	127.6
Facial			
E-line/ UL (mm)	−1.0	−0.9	−0.9
E-line/ LL (mm)	1.2	−0.2	−0.1

ANB: A point nasion B point, FMA: Frankfort mandibular plane angle, L1: Lower central incisor, LL: Lower lip, MP: Mandibular plane, NA: Nasion point A, NB: Nasion point B, SNA: Sella nasion point A, SNB: Sella nasion point B, U1: Upper central incisor, UL: Upper lip

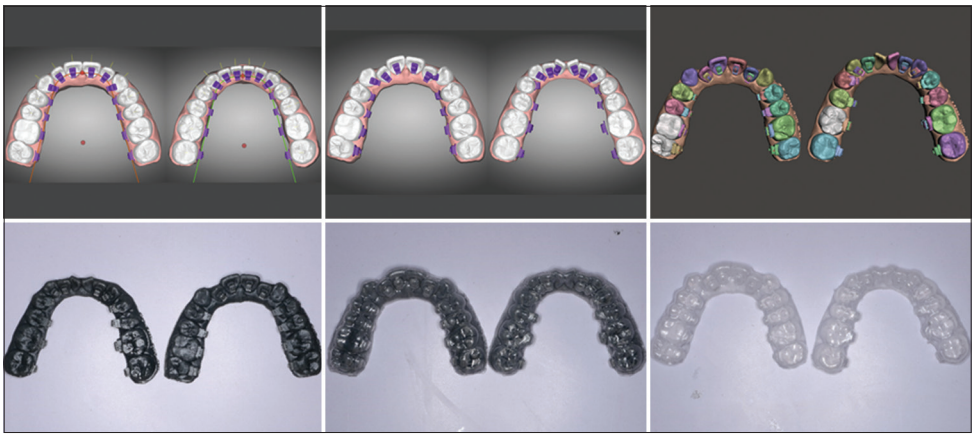

Figure 4: Digital bracket placement and thermoforming indirect bonding tray fabrication.

placement and 3D printed with Sonic Mighty 4K printer (Phrozen, Hsinchu, Taiwan) using Study Model 2 resin (Sprintray, California, USA). After printing, the models were cleaned in isopropyl alcohol 91% and cured in Post Curing UV Lamp (Phrozen, Hsinchu, Taiwan). Supports on resin brackets were removed by burs not to break bracket parts. The indirect bracket bonding trays were made by thermoforming procedures with two layers, BIOPLAST (Scheu, Iserlohn, Germany) for the inner soft layer and BIOCRYL (Scheu, Iserlohn, Germany) for the outer hard layer.[14] Alternatively, the indirect bonding trays could be directly printed using a 3D printer and a suitable resin.[15] Finally, the lingual brackets were inserted into the bonding trays.

The treatment was initiated by bonding all teeth with 0.018×0.025-inch passive self-ligating lingual brackets (JK SL bracket; In Tendo, Nottinghamshire, UK) except maxillary canines and mandibular central incisors due to lack of space. After gaining adequate space with open coil springs, these teeth would be bonded using the individual tooth indirect bonding tray fabricated by the same procedure applied for printed setup models with resin brackets. Archwire sequencing was 0.012, 0.014, 0.016 × 0.016 and 0.016 × 0.022 Nickel-titanium (NiTi) archwires during alignment and 0.016 × 0.022 stainless steel archwire during total arch distalization. After leveling and alignment stage, the incisors were proclined and anterior open bite developed [Figure 5a].

After 6 months of treatment, two miniscrews (diameter, 1.6 mm; length 8 mm) were inserted in the palatal alveolar bone between maxillary first and second molars and two miniscrews (diameter, 2.0 mm; length 12 mm) were inserted in the mandibular buccal shelf for total distalization of both arches to reduce incisor proclination and close anterior open bite [Figure 5b]. The distalizing forces were applied by power chains from palatal miniscrews directly to lingual brackets of upper anterior teeth and from buccal shelf miniscrews to resin buttons bonded to labial surfaces of lower anterior teeth. Because of the mild Class III dental relationship, the distalizing force in the lower arch (200 g/side) was stronger than that in the upper arch (150 g/side). After 5 months of distalization, Class I dental relationship was achieved with normal overbite and overjet.

During the final stage, the maxillary left canine bracket debonded, 0.016 and 0.16× 0.022 NiTi archwires were used for realignment in the upper arch. Buccal resin buttons were bonded on maxillary left canine, mandibular left lateral incisor, and canine for vertical elastic application [Figure 5c]. No interproximal striping was performed during the entire progress. All appliances were removed after 12 months of active treatment. Fixed retainers were placed in both arches in combination with nighttime wear of clear retainers to maintain long-term stability.

Treatment results

After treatment, Class I canine and molar relationship was achieved with normal overbite and overjet and well-aligned dentition [Figures 6 and 7]. The upper and lower dental midlines were coincident with good interdigitations. The incisor and canine guidance in protrusive and lateral excursions was established without posterior and non-working side interferences. The protrusive lower lip was retracted with improvement of facial harmony.

The panoramic radiograph confirmed adequate root parallelism without root resorption [Figure 8]. Cephalometric superimposition showed that the maxillary incisors were uprighted from 103.3° to 100.5° and the mandibular incisor was uprighted from 97.1° to 94.4° [Figure 9], [Table 1]. The mandibular plane angle was almost maintained. The maxillary and mandibular first molars were distalized by 1.6 mm and 2.1 mm, respectively. The distance of the lower lip to the E-line was reduced by 1.4 mm. The 1-year retention records showed the stability of the treatment result without relapse tendency [Figures 10-12].

Figure 5: (a) Anterior open bite after 4 months of treatment, (b) Improvement of anterior open bite after 2 months of two-arch distalization, (c) Buccal buttons for vertical elastic application after 10 months of treatment.

Figure 6: Post-treatment facial and intraoral photographs.

DISCUSSION

Application of digital setup and lingual bracket placement has been reported in some articles[11,12] in which a third-party company or laboratory would do the work instead of orthodontists. There are some advantages of in-house approach over laboratory one including lower laboratory fee, shorter delivery time, and clinician's independence meaning that when a modification of teeth position is required, the clinician could make the adjustment on the software and

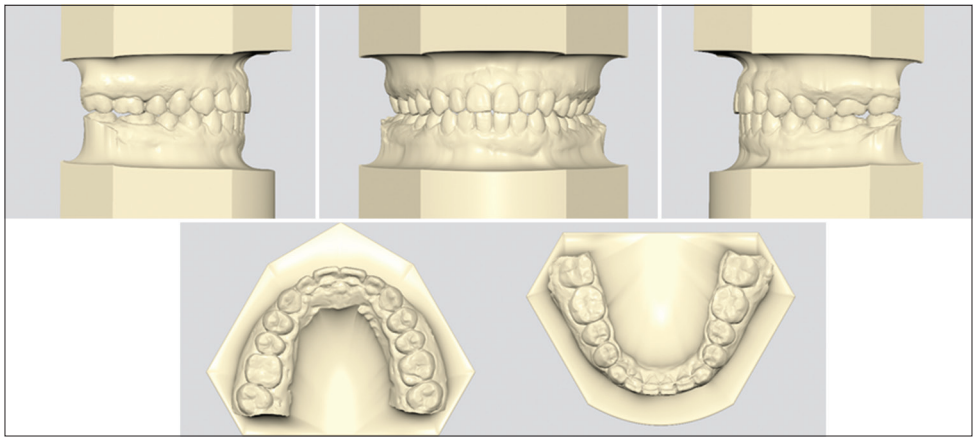

Figure 7: Post-treatment study models.

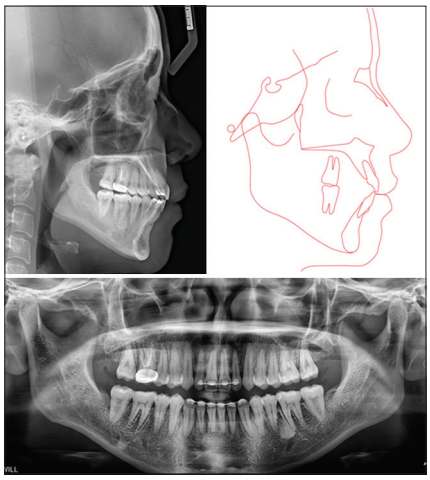

Figure 8: Post-treatment radiographs and tracing.

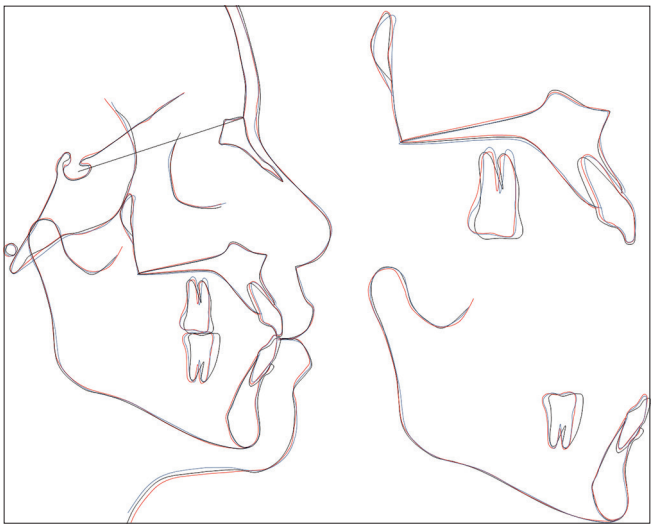

Figure 9: Overall and regional cephalometric superimpositions. Black: Pretreatment, Red: Post-treatment, Blue: 1-year retention.

produce a new indirect bonding tray by himself/herself. There is also a trend toward in office manufacture of other orthodontic appliances including clear aligners, plastic brackets, and metallic devices.[16-19]

In this case report, the thermoforming indirect bonding trays were used with the main disadvantage of lower precision of bracket position when individual tooth is bonded in comparison with the transfer jig described in other articles.[11,12] The cause of the low precision is the imperfect fit between the tray and the labial and incisal or occlusal tooth surfaces when only one tooth is included in the bonding procedure. Current in-house lingual bracket placement software has not yet developed the function to export a printable lingual bracket transfer jig. Therefore, in cases of bracket bonding failure during treatment, the indirect bonding tray is cut and a new bracket is put in and rebonded but with lower precision. Some wire bending may be necessary during the finishing stage to compensate for the less-than-optimal bracket position. Fortunately, the bonding failure rate is usually low as only one bracket was debonded during the entire treatment progress in this case.

The comparison between conventional, passive and active self-ligating brackets was described in some articles.[20,21] The self-ligating brackets have been proven to exhibit lower friction than conventional brackets during the initial leveling and alignment stage.[20] Another main advantage of the self-ligating brackets over the conventional brackets was quicker insertion and removal of small round archwires.[21] This advantage is especially true in lingual orthodontic cases with rotated teeth because the narrow bracket widths and interbracket spans require performing double overties to fully engage the archwire and control the rotation, which is more time-consuming.[22] With later rectangular archwires, the time-saving property is minimized or even reversed because the sliding doors of the passive self-ligating lingual brackets may become clogged over time due to plaque or

Figure 10: One-year retention facial and intraoral photographs.

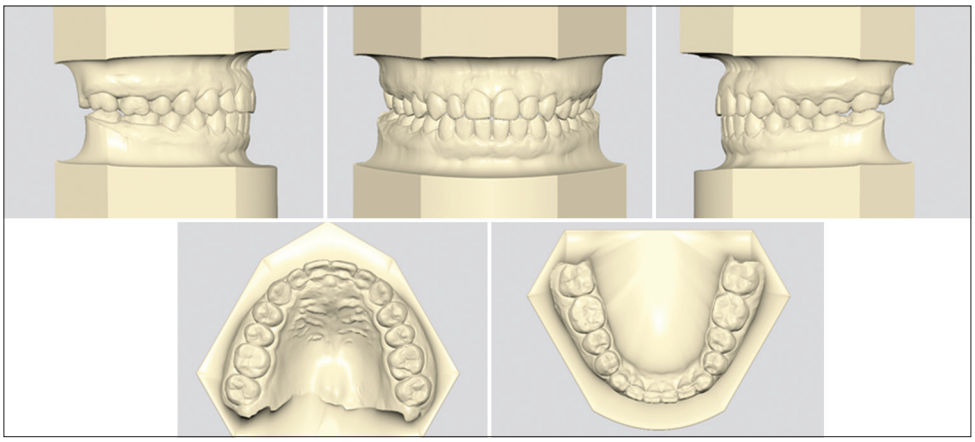

Figure 11: One-year retention study models.

calculus. Also, because of the added thickness of the sliding doors, the bracket slots of the passive self-ligating brackets are usually deeper than that of the conventional brackets which creates more pain during rectangular archwire insertion and removal.[21]

In this case report, the upper and lower incisors were proclined and the anterior openbite developed after the leveling and alignment stage. Miniscrews were used for total distalization of both arches to upright proclined incisors and close the openbite, which created incisor round-tripping. Alternatively, miniscrews could be used in the earlier stage to distalize the buccal segments for space creation and then alignment of the anterior segment could be initiated therefore back-and-forth movement of the incisors would have been avoided to minimize root resorption.[23,24] However, the patient requested the orthodontist to place the miniscrews in the later stage because she worried about the discomfort of the palatal and buccal shelf miniscrews. Nevertheless, the post-treatment panoramic graph showed no root resorption and the total active treatment time was not prolonged.

During the total arch distalization stage in this patient, no archwire hooks were used so that retraction force vectors passed occlusally to the centers of resistance of the entire arches. Therefore, the distalizing force vectors generated a clockwise rotation moment in the upper arch and a counter clockwise rotation moment in the lower arch which extruded

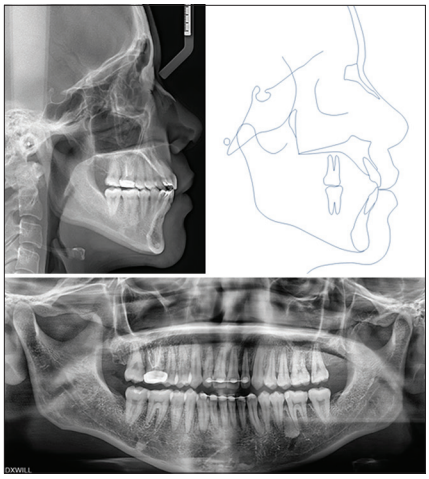

Figure 12: One-year retention radiographs and tracing.

and uprighted the incisors and intruded and tipped the molars distally.[25] These effects are favorable in patients with anterior open bite. In deep bite tendency cases requiring two arch distalization, long hooks should be used to eliminate this rotation moment and miniscrew-assisted incisor intrusion could be applied in severe deep bite cases.[9]

CONCLUSION

In-house digital setup and bracket placement could be a cost-effective approach for indirect lingual bracket bonding. Two-arch distalization with miniscrew anchorage may have the possibility of managing moderate crowding cases without premolar extraction or interproximal stripping.

Author contributions

NVA and TMS were responsible for treatment of the patient and original draft preparation. VTNN and NTA contributed to the literature search, editing, and manuscript review.

Ethical approval

The patient consented in writing to publication of the case.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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