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En-masse distalisation and torque correction in an adult full-step Class-II case treated with a lingual straight-wire appliance

KEYWORDS

Class-II; en-masse distalisation; miniscrews; lingual appliance

ABSTRACT

This case report describes a complex full-step Class-II malocclusion with protrusion of maxillary incisors in an adult patient treated with lingual straight-wire appliance. The two-fold aim was to obtain an ideal occlusal relationship and improvement of smile aesthetics. This report illustrates that an appropriate treatment strategy, including anchorage control by en-masse distalisation and intermaxillary elastics, is needed to achieve the planned results, even with a completely invisible appliance. The placement of miniscrews on the palatal side provided more space for tooth distalisation, thus allowing the correction of a full-step Class-II relationship. An aesthetic buccal sectional was added in the last two months of treatment to correct the maxillary left first premolar, which exhibited a significant torque discrepancy during en-masse retraction.

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Introduction

The en-masse distalisation technique using interradicular miniscrews was proposed by Jeon et al[1] in combination with a buccal appliance. This provides the advantage of reducing molar tipping, typical of a single-tooth distalisation, which often leads to relapse.

A more bodily movement of all elements can be achieved[2], with maxillary and mandibular appliances inserted, while working on the remaining treatment goals. The possibility of positioning miniscrews on the palatal side, combined with a lingual appliance, makes the technique completely invisibile[3]. It also leaves more space for tooth movements[4], in particular when the miniscrews are inserted between maxillary second premolars and first molars, permitting full-cusp Class-II correction with less risk of root contact with the miniscrews. This allows the correction of a full-step Class-II without the need to reposition the miniscrews[3].

Torque control is one of the most difficult aspects of orthodontic treatment, in particular when lingual appliances are employed. However, clinical

Fig 1 Initial frontal extraoral photographs.

Fig 2 Initial lateral extraoral photographs.

Fig 3 Initial radiograph (orthopantomography).

research on lingual orthodontics had demonstrated the ability to very accurately achieve the final result planned in the setup[5-7].

During en-masse distalisation, a three-dimensional control of teeth is requred: a whole arch with a rectangular stainless steel wire ensures high resistance and movement predictability[2], in particular when important sagittal corrections are requested. Nevertheless, single teeth can occasionally exhibit higher torque discrepancies than that which is planned in the setup.

In this case report, an adult deep-bite full-cusp Class-II was treated with a lingual straight-wire appliance by a combination of en-masse maxillary distalisation with inter-radicular palatal miniscrews and intermaxillary lingual elastics. An aesthetic buccal segment of brackets was added for the correction of the maxillary left first premolar that exhibited a significant torque discrepancy during en-masse retraction.

Case presentation

A 19-year-old female patient requested to have her teeth aligned by means of an aesthetic appliance.

The extraoral frontal view shows a decreased lower third and a slight mandibular symphysis deviation combined with a different height of the mandibular angles (Fig 1). From a lateral view, the profile appeared flat, with a balanced nose, a 90-degree nasolabial angle, a marked dental protrusion, normal labio-mental sulcus and a prominent chin (Fig 2). The panoramic radiograph confirmed the presence of all teeth except for mandibular third molars (Fig 3).

Cephalometric analysis (Figs 4 and 5; Table 1) indicated a skeletal Class-II (ANB=4.3 degrees) relationship with the mandible in retruded position (SNB=75.8 degrees). The skeletal pattern was severely hypodivergent (SN/MP=25.4 degrees), with the occlusal plane oriented counter-clockwise. The maxillary incisors appeared normally inclined (112.7 degrees), while the mandibular incisors were slightly proclined (99.5 degrees).

The patient had bilateral full cusp Class-II canine and molar relationships and mild anterior crowding, with the maxillary right lateral incisor displaced palatally and the maxillary left lateral incisor severely rotated (Fig 6).

The maxillary arch was slightly narrow, while the upper and lower curves of Wilson were accentuated. Negative crown torque of the buccal and

Fig 4 Initial radiograph (latero-lateral teleradiography).

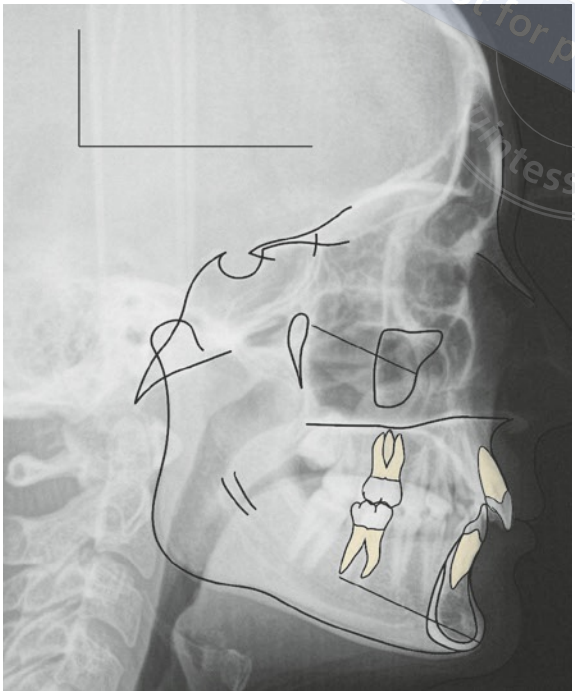

Fig 5 McLaughlin and Tweed cephalometric analysis.

posterior segments were evident in both arches, along with an anterior deep bite and an accentuated lower curve of Spee. The maxillary midline was centered and the mandibular midline was off to the right. The patient's periodontal biotype was thick.

Considering the profile features of the patient (flat profile, 90-degree nose-labial angle, upper and lower lip retrusion, prominent chin), a non-extraction treatment was chosen. This choice was also driven by the lip position with respect to the Ricketts E-line[8].

An alternative strategy would have been to extract the maxillary first premolars. However, this option would have led to maxillary-incisor torque loss during retraction of the anterior teeth and a tendency to deepen the bite.

Orthognathic surgery was considered too invasive for a patient that was not motivated to undergo aesthetic facial change.

Orthodontic treatment was performed using a lingual appliance: this choice was made at the patient's request for an invisible appliance. Furthermore, the favourable biomechanics made it possible to obtain less proclination of mandibular incisors during leveling (as a consequence of intrusion force passing closer to the mandibular incisors' center of resistance)[9].

The orthodontic treatment was performed using the lingual 'straight-wire' technique[10] with Ormco Stb

Table 1 Initial cephalometric values

Cephalometric Morphological Assessment II		
	Pretreatment	**Mean SD**
Sagittal Skeletal Relations		
Maxillary Position S-N-A	**80.1°**	82° ± 3.5°
Mandibular Position S-N-B	**75.8°**	80° ± 3.5°
Sagittal Jaw Relation A-N-B	**4.3°**	2° ± 2.5°
Vertical Skeletal Relations		
Maxillary Inclination S-N/ANS-PNS	**8.1°**	8° ± 3.0°
Mandibular Inclination S-N/Go-Gn	**25.4°**	33° ± 2.5°
Vertical Jaw Relation ANS-PNS/Go-Gn	**17.3°**	25° ± 6.0°
Dento-Basal Relations		
Maxillary Incisor Inclination 1 - PP	**112.7°**	110° ± 6.0°
Mandibular Incisor Inclination 1 - Go-Gn	**99.5°**	94° ± 7.0°
Mandibular Incisor Compensation 1 - A-Pg (mm)	**-2.0 mm**	2 ± 2.0
Dental Relations		
Overjet (mm)	**6.6 mm**	3.5 ± 2.5
Overbite (mm)	**4.9 mm**	2 ± 2.5
Interincisal Angle 1/1	**130.6°**	132° ± 6.0°

Fig 6 Initial intraoral photographs.

(Ormco; Orange, CA) brackets, by means of a manual setup (Fig 7). Torque overcorrections in the anterior, buccal and posterior segments of maxillary and mandibular arches were included in the setup parameters.

Bracket bonding was carried out by single jigs, following the 'Komori system' technique, after the arches were assembled based on the 'Kommon-base' philosophy[11]. After both arches were bonded, a medium 0.013" CuNiTi lingual straight wire (LSW) was placed in the maxillary arch and a small 0.013" CuNiTi LSW in the mandibular arch for initial alignment (Fig 8). Occlusal build-ups were inserted on maxillary second molars with the purpose of

Fig 7 Manual setup.

obtaining a tripodic contact during alignment and leveling phases. Open coil springs were inserted between the maxillary left central incisor and canine in order to gain space for bonding brackets on the maxillary left lateral incisor. A closed elastomeric chain was inserted between the maxillary right canine and first premolar to increase interbracket distance between maxillary right canine and lateral incisor.

Two months later a 0.018*0.018'' CuNiTi LSW Ormco Stb Small was inserted in the mandibular arch for leveling and torque establishment. A provisional bracket was bonded on maxillary left lateral incisor to start rotation correction.

Three months after treatment began, a Stb bracket was bonded to the maxillary left lateral incisor. A closed elastomeric chain was inserted between the maxillary left lateral incisor and canine to facilitate their complete de-rotation.

One month later, an 0.018*0.018'' CuNiTi LSW Ormco Stb Medium was inserted in the maxillary arch for leveling and torque establishment. A closed elastomeric chain was inserted between maxillary second premolars with the aim of avoiding space opening.

Following a two-month period, inter-radicular miniscrews (Vector TAS; Ormco) were inserted on the palatal side for en-masse distalisation (Fig 9). An 0.018*0.018'' stainless steel (SS) posted Ormco Stb was inserted in the maxillary arch with the addition of 12-22 root-palatal torque and additional Spee compensation curve. A closed elastomeric chain was inserted between maxillary first premolars with the aim to avoid space opening. 3/16" 6 oz Impala Ormco Class-II elastics were prescribed 24 h/day to obtain complete Class-II correction.

Eight months after the start of treatment, a 0.0175*0.0175'' TMA LSW Ormco Stb Small was inserted in the mandibular arch for its leveling. A slight anti-Spee curve was included in order to obtain a complete curve of Spee flattening. A closed elastomeric chain was inserted between mandibular first premolars with the aim to close spaces.

After a period of six months, the maxillary left canine was rebonded, and an 0.018"*0.018" CuNiTi LSW STb Medium wire was inserted in the maxillary arch. An upper closed elastomeric chain was placed from the right inter-radicular miniscrew to the left interradicular miniscrew, passing through the anterior segment from the maxillary right to the

Fig 8 Maxillary and mandibular arch bonding. Insertion of 0.013 CuNiTi LSW Ormco Stb Small on the mandibular arch. Insertion of 0.013 CuNiTi LSW Ormco Stb Medium on the maxillary arch. Insertion of build-ups on maxillary second molars. Insertion of open coil spring between the maxillary left central incisor and the canine. Insertion of elastomeric chain between the maxillary right canine and the maxillary right first premolar.

maxillary left canine to continue en-masse retraction. 3/16" 6 oz Impala Ormco Class-II elastics were continued 24 h/day to obtain complete Class-II correction.

One month later, a 0.018*0.018 SS posted Ormco Stb was reinserted in the maxillary arch with the increase of 12-22 root-palatal torque and additional Spee compensation curve. A closed elastomeric chain was added between maxillary second premolars in order to avoid space opening. A closed elastomeric chain was added between mandibular first premolars in order to close spaces (with a

Fig 9 Insertion of interradicular miniscrews. 0.018*0.018 SS posted Ormco Stb insertion in the maxillary arch. Insertion of a closed elastomeric chain between maxillary first premolars. 3/16" 6 oz Impala Ormco Class-II elastics were used 24 h/day.

single eyelet inserted between the mandibular right central incisor and the lateral incisor).

Twenty-two months after treatment began, class I canines and molars were obtained. The closed elastomeric chain was replaced between mandibular first premolars in order to complete spaces closure (with a single eyelet inserted between central incisors and bilaterally from lateral incisor to canine). A closed elastomeric chain was added between the mandibular right second premolar and the first molar in order to assist in their rotation.

Fig 10 Insertion of a buccal 0.018*0.018 CuNiTi LSW Ormco sectional wire. Insertion of elastomeric chains between the maxillary second molars and the mandibular second molars. Metallic button bonding on the mandibular left second molar's buccal surface.

Despite symmetrical mechanics with en-masse distalisation and intermaxillary elastics, the maxillary left first premolar showed a palatal root-torque with a significant buccal inclination.

One month later, a buccal segment with Ormco esthetic Ice brackets (Ormco) were placed from the maxillary left canine to second premolar with a 0.013 CuNiTi LSW Ormco wire. On the lingual side, the maxillary left canine was rebonded and an 0.018"*0.018" CuNiTi LSW STb Medium wire was inserted in the maxillary arch. An upper closed elastic chain was inserted from the right inter-radicular

miniscrew to the left inter-radicular miniscrew, passing through the anterior segment from the maxillary right to the maxillary left canine to continue en-masse retraction. Intermaxillary elastics usage was stopped.

One month later, rotation finishing bends on #34, #41, #42 and a tip finishing bend on #35 were performed. An elastomeric chain between mandibular second molars was inserted in order to complete space closure (with a single eyelet included bilaterally between central and lateral incisors and between canine and first premolar).

Two weeks later, a buccal 0.018*0.018 CuNiTi LSW Ormco sectional wire was inserted in order to complete maxillary left first premolar torque correction (Fig 10). Elastomeric chains were inserted in maxillary and mandibular arches from second molar to second molar to keep the spaces closed. A metallic button was bonded on mandibular left second molar buccal surface in order to prescribe the patient 3/16" 6 oz Impala Ormco Class-II elastics from the maxillary left second premolar to the mandibular second molar on buccal side to obtain complete Class-II correction on the left side.

After twenty-four months of treatment, brackets were debonded and the upper miniscrews were removed. Maxillary 12-22 and mandibular 33-43 fixed lingual retainers were directly bonded, and maxillary and mandibular Essix were delivered.

A solid canine and molar class I relationship was obtained on both sides, with aligned arches, flat curve of Spee on the mandibular arch and complete resolution of the deep bite. Good canine and anterior guidance was obtained at the end of treatment.

Final treatment frontal photographs show a proper smile arch and a significant improvement in smile aesthetics (Fig 11). The final lateral extraoral photographs show maxillary incisor protrusion reduction and facial balance maintained compared to the start of treatment (Fig 12). A slight asymmetry remained with a slight chin deviation to the right side (Fig 13).

The final orthopantomogram showed root parallelism between the elements (Fig 14). The cephalometric values displayed improvement of facial and dental relations (Fig 15; Table 2). Maxillary incisor torque was slightly reduced from 112 to 107 degrees, and mandibular incisors showed a proclination of 99.5 to 107 degrees. The Ricketts E line[8] was unchanged and confirmed the correct decision not to extract.

Fig 11 End of treatment, frontal extraoral photographs.

Fig 12 End of treatment, lateral extraoral photographs.

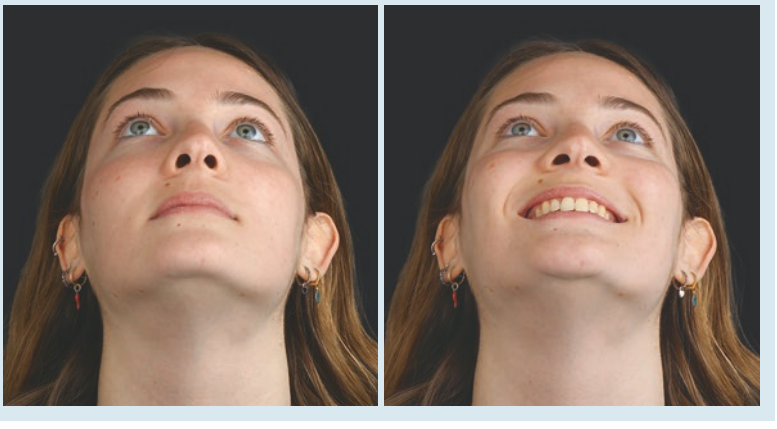

Fig 13 End of treatment, submental photographs.

Fig 14 End of treatment, radiograph (orthopantomography).

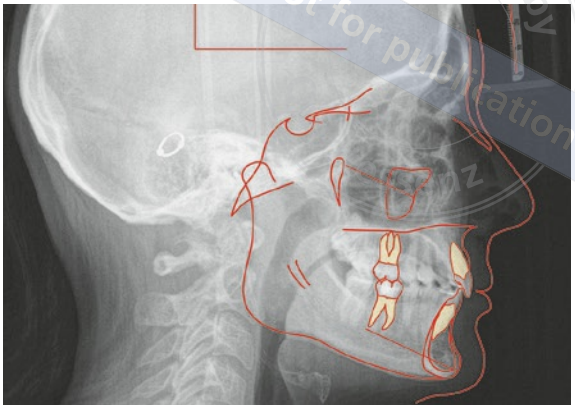

Fig 15 Cephalometric analysis.

Table 2 Final cephalometric values

Cephalometric Morphological Assessment II			
	Pretreatment	Posttreatment	Mean SD
Sagittal Skeletal Relations			
Maxillary Position S-N-A	**80.1°**	**79.5°**	82° ± 3.5°
Mandibular Position S-N-B	**75.8°**	**76.0°**	80° ± 3.5°
Sagittal Jaw Relation A-N-B	**4.3°**	**3.4°**	2° ± 2.5°
Vertical Skeletal Relations			
Maxillary Inclination S-N/ANS-PNS	**8.1°**	**7.4°**	8° ± 3.0°
Mandibular Inclination S-N/Go-Gn	**25.4°**	**24.9°**	33° ± 2.5°
Vertical Jaw Relation ANS-PNS/Go-Gn	**17.3°**	**17.5°**	25° ± 6.0°
Dento-Basal Relations			
Maxillary Incisor Inclination 1 - PP	**112.7°**	**107.2°**	110° ± 6.0°
Mandibular Incisor Inclination 1 - Go-Gn	**99.5°**	**107.4°**	94° ± 7.0°
Mandibular Incisor Compensation 1 - A-Pg (mm)	**-2.0 mm**	**-0.9 mm**	2 ± 2.0
Dental Relations			
Overjet (mm)	**6.6 mm**	**2.5 mm**	3.5 ± 2.5
Overbite (mm)	**4.9 mm**	**2.4 mm**	2 ± 2.5
Interincisal Angle 1/1	**130.6°**	**128.0 °**	132° ± 6.0°

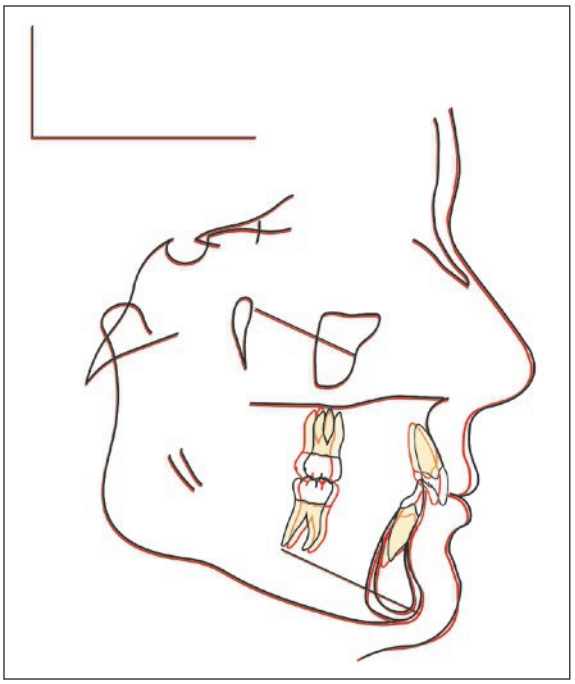

Fig 16 General superimpositions.

Superimposition of pre-and post-treatment cephalometric tracings (carried out according to the methodology described in the image captions), as developed by Professor Arne Björk[12,13], demonstrated that the correction was mainly obtained by means of dento-alveolar movements (Figs 16 and 17). Maxillary molars were distalised and vertically controlled, while mandibular molars were mesialised and slightly extruded. At the level of the incisors, the superimposition confirmed that good light contact had been achieved.

The control photographs take six months later show the initial stability of the treatment (Figs 18 to 21). The comparison between pre-post extraoral (Figs 22 to 25) and intraoral (Figs 26 to 28) photographs demonstrates the dramatic aesthetic and functional improvement obtained by the orthodontic treatment.

Discussion

In the present case report, a deep-bite full-cusp Class-II malocclusion in an adult patient was corrected with a lingual straight-wire appliance by a combination of en-masse maxillary distalisation

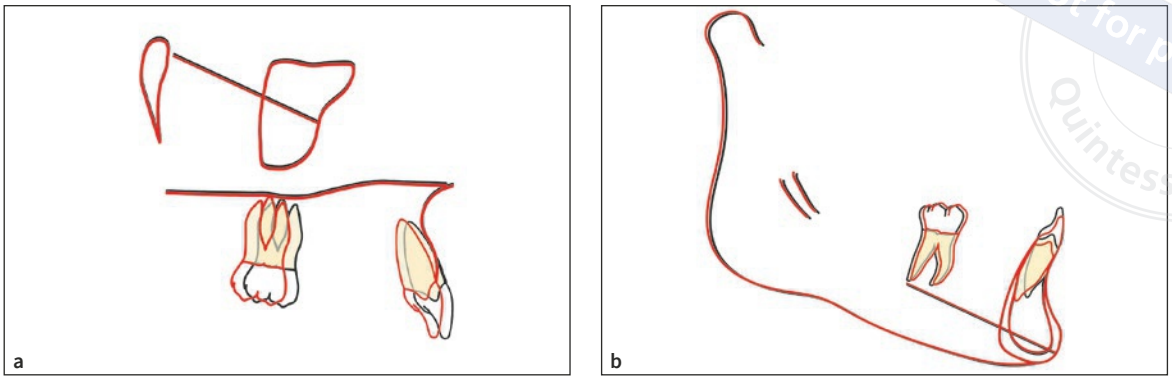

Fig 17 Maxillary and mandibular sectorial superimpositions.

Fig 18 Six-month distance intraoral photographs (frontal and lateral).

Fig 19 Six-month distance intraoral photographs (occlusal and particular).

Fig 20 Six-month distance frontal extraoral photographs.

Fig 21 Six-month distance lateral extraoral photographs.

Fig 22 Before and after frontal extraoral photographs.

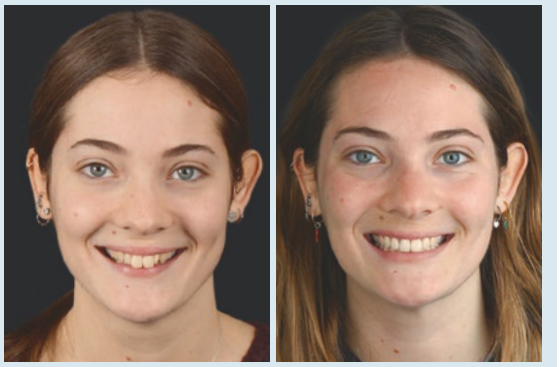

Fig 23 Before and after frontal extraoral photographs.

Fig 24 Before and after lateral extraoral photographs.

Fig 25 Before and after lateral extraoral photographs.

Fig 26 Before and after frontal intraoral photographs.

Fig 27 Before and after lateral intraoral photographs.

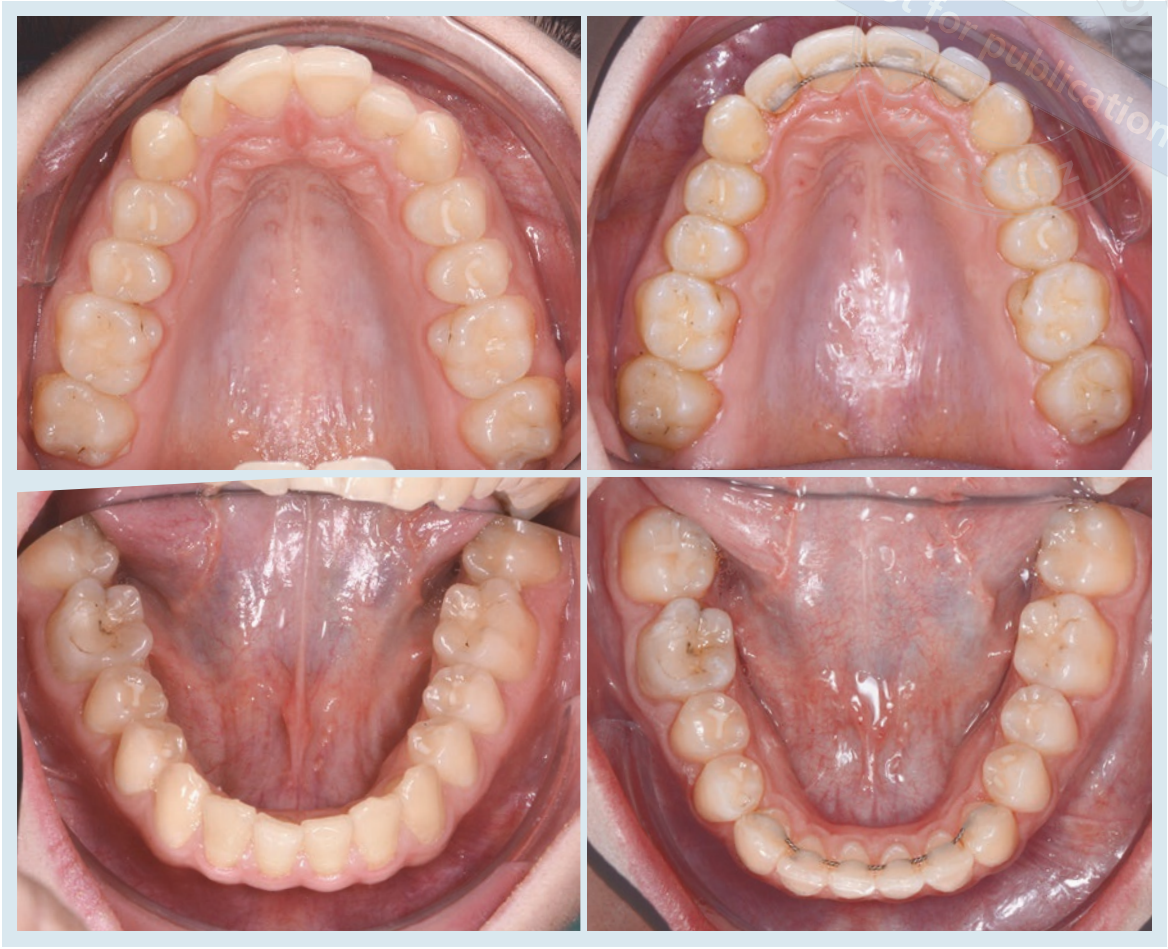

Fig 28 Before and after occlusal intraoral photographs.

(performed with interradicular miniscrews) and intermaxillary lingual Class-II elastics. An aesthetic buccal segment was inserted in order to correct maxillary left first premolar torque which demonstrated marked root-palatal torque during the en-masse distalisation.

The en-masse distalisation technique using interradicular miniscrews in combination with buccal appliance was proposed by Jeon et al[1]. Bechtold et al found that a pair of interradicular miniscrews provided enough anchorage for efficient en-masse maxillary distalisation to correct an end-to-end Class-II malocclusion using a labial technique[14], while the removal and reinsertion of miniscrews during treatment was necessary for the correction of a full step Class-II malocclusion[15].

Positioning the inter-radicular miniscrews on the palatal side, in combination with a lingual appliance, provides more space for tooth movements[3], permitting full-cusp Class-II correction with less risk of root-surface contact by the miniscrews. As opposed to the buccal side, it is not necessary to remove and reinsert the miniscrews during treatment, which avoids contact and consequent damage to the root surface. Although it has been demonstrated that the damage to the root surface by the titanium miniscrew during tooth movement is reversible[16], apical tilting of the insertion path and approximating the miniscrew toward the tooth on the distal side is however recommended to avoid root contact[3].

This method offers an advantage over palatal anchorage, namely, the simplicity of the insertion procedure: no complex planification with CBCT is required for screw positioning[17]. In addition, it is not necessary to fabricate connecting parts[18]: a direct force can be applied from the miniscrews to the power arm, with a vector passing close to the center of resistance of the maxillary arch.

The advantage in comparison with extra-alveolar bone sites such as the infrazygomatic crest is represented by the lower failure rate: the nature of the movable gingiva at the insertion site combined with poor accessibility to this site during insertion and cleaning are clinical shortcomings of the infrazygomatic site[19]. In addition, the placement of miniscrews in the infrazygomatic region and their removal at the end of treatment require surgical procedures on each side, increasing the cost of the procedure[20].

The choice to employ the lingual technique with clear aligners was based on the higher accuracy between the final result and the movements planned in the setup[5-7]. In addition, effective en-masse distalisation would have been impossible with the use of removable aligners, since continuous forces are recommended[14].

In the present case, attempting complete correction with Class-II elastics but without en-masse distalisation would have made it difficult to obtain complete Class-II correction. In addition, proclination of the mandibular incisors would have been excessive due to Class-II mechanics with intermaxillary elastics.

However, as expected, a combination of mandibular-incisor proclination and intrusion occurred. The thick gingival biotype and the adequate symphysial bone volume permitted proclination without periodontal risks[21,22].

During en-masse distalisation, despite using a continuous arch with a square stainless steel 0.018*0.018'' archwire and symmetric mechanics, the maxillary left first premolar exhibited marked palatal-root torque. Clinical studies on lingual orthodontics demonstrated the possibility of very accurately achieving the final result planned in the setup[5-7] also regarding torque control.

In a clinical study on 20 consecutively treated patients, Pauls et al[6] found very low torque discrepancies between the final and the planned results (2.96 degrees in anterior segment) with a slightly greater difference in buccal segment (5.18 degrees). In a clinical study on 40 patients comparing differences between the final and planned results which also considered the initial position of the teeth, Albertini et al[7] found very small differences (between 85% and 92%) for incisors, canines and premolars, whereas the accuracy for molars was between 52% (maxillary second molars) and 81% (mandibular first molars), due to their terminal position. This discrepancy of maxillary left first premolar inclination can be explained by differences in two factors: the initial tooth position and interproximal contacts during en-masse distalisation between the adjacent teeth of the left buccal segment.

Although the initial position of the maxillary left first premolar (intruded and with palatal root-torque inclination) was vertically overcorrected in the setup, an extrusive force applied on the lingual side was not effective for obtaining a complete correction. The third-order movement performed through the square 0.018*0.018 stainless steel archwires was not completely effective, due to the unfavourable moment ratio[23] with a short distance for the couple of force application.

The combination of the lingual appliance with an aesthetic buccal segment allowed three-dimensional control and correction of the torque discrepancy. First, a round 0.013 CuNiTi wire was employed, followed by a 0.018*0.018 CuNiTi wire. Despite the remaining play in a 0.022*0.028 slot buccal bracket (Ormco, Ice) the combination between inner- and outer-bracket appliances enabled three-dimensional control. The final position of the maxillary first left premolar permitted ideal intercuspation without premature contacts during functional movements, both on working and non-working sides.

A significant post-rotation of the occlusal plane (from 6.7 to 11.6 degrees of PP/OP) was recorded at the end of treatment. In this deep-bite case, this yielded a favourable result, increasing maxillary incisor exposition during smiling.

The clockwise rotation of the occlusal plane, which was reported in previous studies of distalisation with miniscrews[23,24], was enhanced by the use of Class-II intermaxillary elastics.

Conclusion

En-masse distalisation and Class-II intermaxillary elastics were used to sagittally correct a full-cusp Class-II malocclusion in an adult patient in 24 months.

Except for the aesthetic buccal segment added in the final two months for maxillary left first premolar torque correction, the lingual appliance with all auxiliaries on the lingual side was completely invisible, as requested by the patient.

The inter-radicular palatal position of the miniscrews between the maxillary second premolar and first molar allowed en-masse distalisation for full-cusp Class-II correction without removing and reinserting them. The favourable biomechanics caused occlusal plane post-rotation, increasing incisal exposure during smiling.

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En-masse-Distalisierung und Torquekorrektur bei Klasse II-Malokklusion mit lingualer Straight-wire-Apparatur

INDIZES

Klasse II, En-masse-Distalisierung, Minischrauben, Lingualapparatur

ABSTRACT

In diesem Fallbericht wird eine komplexe Klasse II-Malokklusion mit Protrusion der oberen Schneidezähne bei einem erwachsenen Patienten beschrieben. Dieser wurde mit einer lingualen Straight-wire-Apparatur behandelt, um eine ideale Okklusionsbeziehung und eine Verbesserung der Ästhetik zu erreichen. Vor diesem Hintergrund wird unterstrichen, dass eine geeignete Behandlungsstrategie, einschließlich der Kontrolle der Verankerung durch En-Masse-Distalisation und intermaxilläre Gummizüge erforderlich ist, um die geplanten Ergebnisse auch mit einer völlig unsichtbaren Apparatur zu erzielen. Die Platzierung von Minischrauben auf der palatinalen Seite bietet mehr Platz für die Distalisierung der Zähne und ermöglicht so die Korrektur einer Klasse II-Beziehung. In den letzten zwei Monaten der Behandlung wurde zur Korrektur des oberen linken ersten Prämolaren eine vestibuläre Teilapparatur hinzugefügt.

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