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Case Report

Management of Anterior Open Bite and Skeletal Class II Hyperdivergent Patient with Clear Aligner Therapy

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Main Points

- This Invisalign case represents the biomechanical aspect to consider for the open bite and hyperdivergent case.
- An asymmetric mechanism is used to correct the anteroposterior discrepancy.
- Utilizing the advantages of the active biteblocks helped to maintain and improve the vertical molar positions.

ABSTRACT

In orthodontics, patients with hyperdivergent facial types or problems in the vertical dimension are often challenging to treat with predictable treatment results. Conventionally along with fixed appliances, a headgear, posterior bite block, extraction, temporary anchorage devices, or orthognathic surgery are preferable approaches to treat such patients. This case report illustrates a non-extraction, non-surgical orthodontic treatment of 5 mm anterior open bite in a non-growing adult patient, utilizing clear aligner therapy.

Keywords: Open bite, clear aligner therapy, molar intrusion, sagittal discrepancy

INTRODUCTION

The management of problems in the vertical dimension is often challenging to treat, and more importantly, the stability of correction is unpredictable. Traditionally, these patients are treated with headgear, posterior bite blocks, and extraction of premolar teeth, mini-implants-assisted molar intrusion, or orthognathic surgery.[1] With the introduction of mini-implants, the mild to moderate skeletal open bite cases can be treated predictably with molar intrusion, as documented by numerous case reports.[2,3] Buschang et al.[4] documented favorable facial changes in Class II retrognathic and hyperdivergent subjects after mini-implant-assisted molar intrusion.

Recently, clear aligners or aligners combined with mini-implant have shown some promising results in managing mild to moderate skeletal Class II hyperdivergent cases.[5-7] Most of the patients treated were mild cases with incisor extrusion and minimal evidence of posterior teeth intrusion. However, recent retrospective studies evaluated the dental and associated skeletal changes after clear aligner treatment.[8,9] The open bite malocclusion improved due to a combination of maxillary and mandibular molar intrusion and maxillary and mandibular incisor extrusion.

Based on the current evidence, the clear aligners may be successful in managing patients with mild to moderate skeletal open bite. Hence, the aim of this case report is to document the management of skeletal open bite in an adult patient with clear aligner treatment.

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Diagnosis and Etiology

A 26-year-old female patient sought orthodontic treatment with the chief complaint of anterior open bite and underbite. The patient was in good health, exhibited good oral hygiene, and had no harmful oral habits, caries, or periodontal problems that contraindicated orthodontic treatment. There was no history of trauma to the oral region.

The patient had a convex soft tissue profile with competent lips and reverse smile arc on extraoral examination. Intraoral examination showed a full step Class II molar relationship on the left side and half-cusp Class II on the right side, with a narrow maxillary arch. Overjet of 5 mm and 5 mm anterior open bite were observed extending from the upper second premolar on the left side to the first premolar of the right side. The model analysis revealed 6 mm of crowding in the upper arch with 2 mm of lower midline shift toward the left side and flat curve of Spee (Figures 1 and 2).

The cephalometric analysis revealed that the patient had a skeletal Class II malocclusion (ANB = 7.9°, Wits appraisal = 4.7 mm) with mild hyperdivergent growth pattern (Mandibular plane [MP] to SN = 34.5°) and upright upper and slightly proclined lower incisors (U1-PP 102.4°, Incisor mandibular plane angle [IMPA] = 96.6°) (Table 1, Figure 3). No significant pathology was found in the panoramic radiograph (Figure 4). Based on clinical and cephalometric findings, our diagnosis was skeletal Class II

Figure 1. Pretreatment photographs

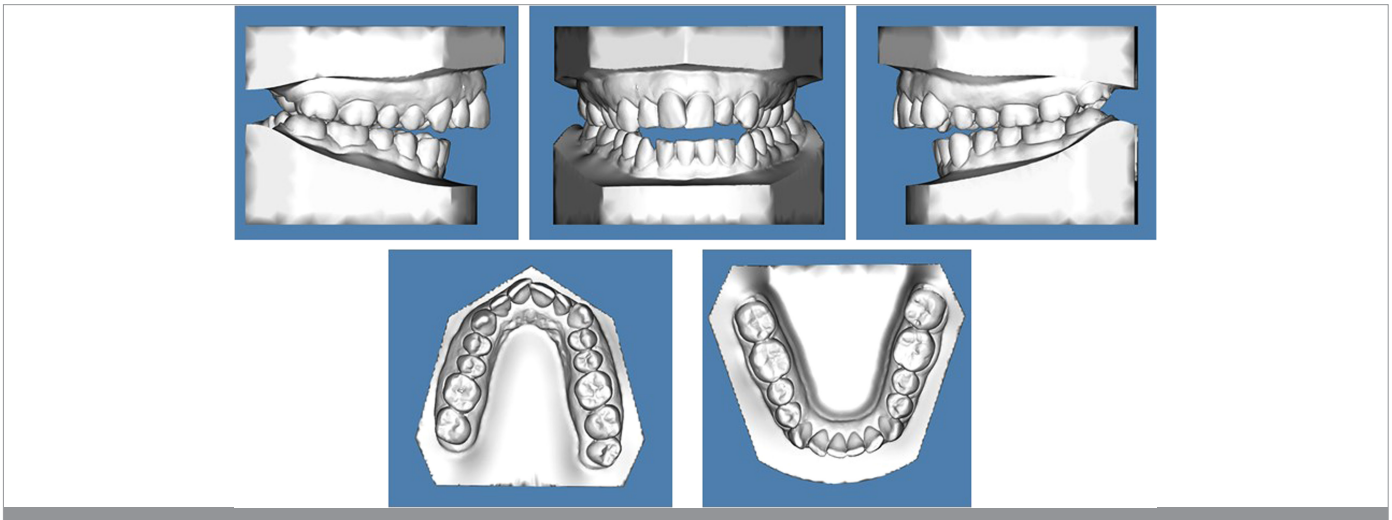

Figure 2. Pretreatment dental casts

Table 1. Cephalometric measurements

Parameter	Pretreatment	Posttreatment	Change
SNA (°)	84	83.4	−0.6
SNB (°)	76.2	76.8	0.6
ANB (°)	7.9	6.6	−1.3
Wits appraisal (mm)	4.7	0.8	3.9
Angle of convexity (°) N-A-Pog	15.6	14.7	0.9
MP-SN (°)	34.5	33.1	−1.4
U1-PP (°)	102.4	97.7	−4.7
IMPA	96.6	100.4	3.8
LAFH (ANS-Me)	70.7	70.5	−0.2
U1-PP (mm)	30	33.6	3.6
U6-PP (mm)	24.8	22.7	−2.1
L1-MP (mm)	37.6	38.9	1.3
L6-MP (mm)	33.1	32.7	−0.4
Ar-Go-Me (°) (gonial angle)	127	122.9	4.1

U6-PP, Upper first molar to palatal plane; L1-MP, Lower incisor to mandibular plane; L6-MP, Lower first molar to mandibular plane.

due to retrognathic mandible and mild hyperdivergent growth pattern, Angle's Class II molar relation with increased overjet and anterior open bite with convex soft tissue profile, and non-consonant smile arc.

Treatment Objective

The treatment objectives were (1) to correct the anterior open bite and achieve ideal overjet and overbite, (2) to achieve Class I molar and canines bilaterally, (3) to improve or prevent worsening of lower anterior facial height, and (4) to maintain the facial balance, improve the soft tissue profile, and achieve a consonant smile arc.

Treatment Alternatives

The patient was offered 3 treatment options which were: orthognathic surgery, a non-surgical, non-extraction option with mini-implant-assisted molar intrusion, and clear aligner.

1. Orthognathic surgery: Bimaxillary surgery with Lefort 1 maxillary posterior impaction and segmental osteotomy and bilateral sagittal split osteotomy of mandible with advancement was recommended to the patient. This can lead to autorotation of the mandible and correct the anterior open bite. The major advantage of this approach was predictability and shorter treatment duration. However, the comorbidities associated with orthognathic surgery are a significant limitation.
2. Non-extraction, non-surgical treatment with Temporary Anchorage Device (TADs): Although the outcome of molar intrusion using TADs is comparable with surgery, appropriate biomechanical consideration is critical for the success of the treatment. Numerous variables such as the number of TADs, area of placement (buccal or palatal), type of anchorage should be considered in order to obtain optimum

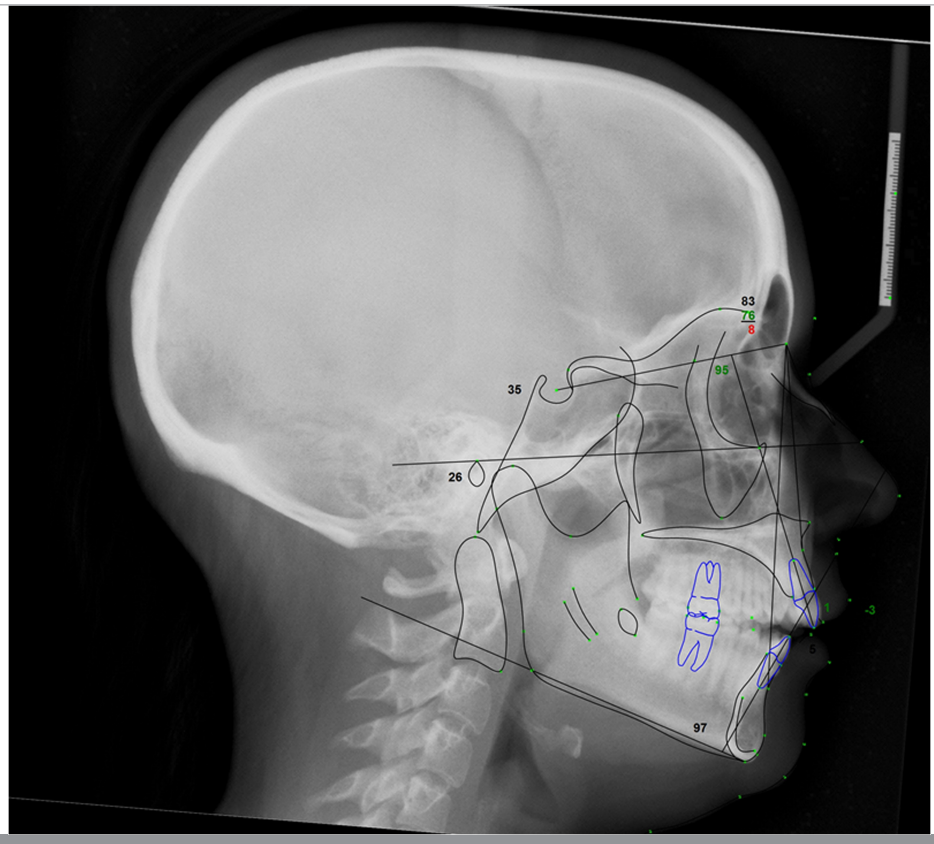

Figure 3. Pretreatment lateral cephalometric radiograph

Figure 4. Pretreatment panoramic radiograph

outcome and minimize the treatment time. Additionally, TAD failures can prolong the treatment time.

3. Non-extraction, non-surgical treatment with clear aligners: This was the most conservative approach for dentoalveolar correction without any surgical intervention or TAD placement. Molar intrusion and bite block effect produced by aligners on posterior teeth may lead to autorotation of the mandible and help with the anterior open bite correction. Also, upper and lower anterior uprighting and extrusion will help to close the bite further.

All of these options were presented to the patient, and benefits to risk assessment of each of the options were discussed. The patient specifically demanded an aesthetic treatment approach using clear aligner therapy and did not want any surgical intervention or fixed orthodontic treatment. After the discussion with the patient, she elected for clear aligner treatment, and written informed consent was obtained from the patient before beginning the treatment.

TREATMENT PROGRESS

In the first ClinCheck, a significant amount of upper and lower molar intrusion and incisor extrusion was programmed (Figure 5 and Table 2). The rationale was to correct the anterior open bite with the combination of mandibular autorotation and upper and lower anterior teeth extrusion. Initial Clincheck instructions included 5 mm rectangular vertical attachments on the occlusal surface of maxillary and mandibular first and second molars to contact each other throughout treatment to get the posterior bite block effect (Figures 6 and 7). A total of 43 sets of aligners, including 3 overcorrection aligners, were staged in the initial ClinCheck approval. The patient was instructed to wear trays 20-22 hours a day and change to the next set every 7 days. She was advised to wear 1/4-inch, 4.5 oz Class II elastics with the initial trays.

At the end of the initial set of trays, the patient still had end-on molar on the right side and slight improvement on the left side, premature contact at the upper left canine, and a large dark triangle between upper central incisors with 2 mm open bite. The first refinement was planned with instructions to expand the upper arch and an Interproximal reduction (IPR) of 0.5 mm between upper central incisors to address premature contact and black triangle (Figure 7, Table 3). Also, an IPR of 0.2 mm per contact was planned between lower first premolar to premolar to allow mesial movement of lower posterior teeth with class II elastics. To resolve issues with asymmetric molar relationship and lower midline, asymmetric Class II elastics (right side:

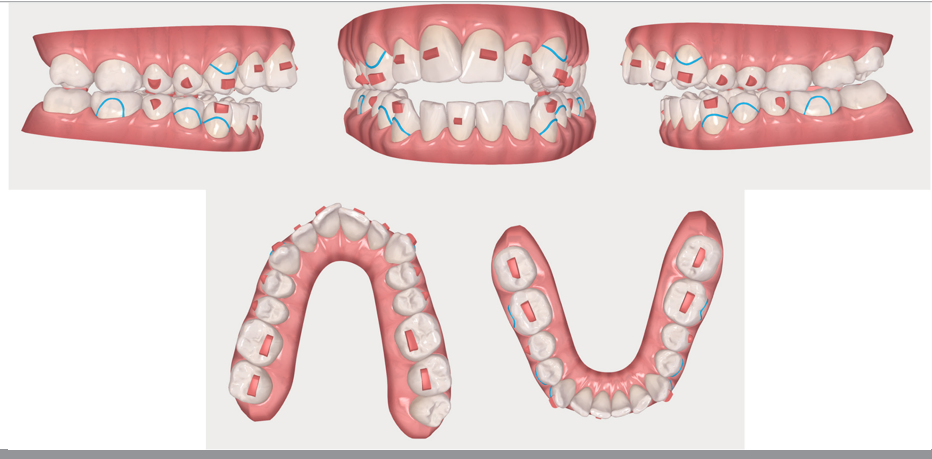

Figure 5. Pretreatment ClinCheck images

Table 2. Programmed crown movement in the ClinCheck software

Programmed Crown Movement																
Teeth	**UR8**	**UR7**	**UR6**	**UR5**	**UR4**	**UR3**	**UR2**	**UR1**	**UL1**	**UL2**	**UL3**	**UL4**	**UL5**	**UL6**	**UL7**	**UL8**
Extrusion/ intrusion (mm)	-	**1.1 I**	**0.8 I**	0.1 I	0.4 E	0.1 E	**0.9 E**	**0.8 E**	**0.8 E**	**1.3 E**	0.2 E	0	0	**0.7 I**	**1.2 I**	0.6 I
Translation buccal/lingual	-	0.5 B	0.9 B	2.4 B	2.3 B	1.6 B	1.2 B	0.8 L	0	0.9 B	0.1 B	2.6 B	2.6 B	2.2 B	1.3 B	0.9 B
Translation mesial/distal	-	0.1 D	0.2 D	0.2 D	0.4 D	0.5 D	1.0 D	0.9 D	0.6 D	0.4 D	0.4 D	0.2 D	0.1 M	0.1 D	0.1 D	0.4 D
Rotation (°)	-	12.1 D	13.7 D	5.3 D	3.1 M	29.9 D	2.7 D	28.6 M	15.1 M	15.8 M	0.3 D	3.8 M	4.1 D	9.6 D	4.5 D	1.6 D
Angulation (°)	-	2.0 D	2.7 D	1.1 M	0.4 D	8.7 D	4.4 D	0.3 M	0.3 M	6.4 D	7.4 D	3.0 D	2.1 D	2.7 D	0.5 D	0.7 D
Inclination (°)	-	1.0 L	0.2 L	7.1 B	10.4 B	7.1 B	2.6 B	5.0 B	5.9 B	3.0 B	0.1 B	13.4 B	8.6 B	5.3 B	0.4 L	2.4 L
Teeth	**LL8**	**LL7**	**LL6**	**LL5**	**LL4**	**LL3**	**LL2**	**LL1**	**LR1**	**LR2**	**LR3**	**LR4**	**LR5**	**LR6**	**LR7**	**LR8**
Extrusion/ intrusion (mm)	-	**0.8 I**	**1.4 I**	0.9 I	0	0.2 E	**0.9 E**	**1.2 E**	**1.2 E**	**1.2 E**	0.7 E	0.1 E	0.5 I	**1.2 I**	**1.3 I**	-
Translation buccal/lingual	-	3.4 L	1.6 L	0.1 B	0.4 B	0	0.6 B	0.8 B	0.6 B	0.3 B	0.1 L	0.8 B	1.5 B	1.5 B	1.8 B	-
Translation mesial/distal	-	0.5 D	0	0.1 M	0.2 M	0	0.1 M	0.1 D	0.4 M	0.5 M	0.2 M	0.2 M	0	0.2 D	0.1 M	-
Rotation (°)	-	24.3 D	17.5 D	18.2 D	17.9 D	14.2 M	12.6 M	10.5 M	12.4 M	16.1 M	21.3 M	11.4 D	0.6 D	4.2 D	4.7 D	-
Angulation (°)	-	2.4 M	0.2 D	1.5 M	2.1 D	2.8 D	1.8 M	1.8 D	0.4 M	0.4 M	1.4 D	5.0 D	1.8 M	1.1 M	0.5 M	-
Inclination (°)	-	5.7 L	3.2 L	2.1 L	0.6 B	0.6 L	1.6 B	2.3 B	0.9 L	1.4 B	1.7 L	0.7 L	1.1 L	1.4 B	0.5 L	-

UR, Upper right; UL, Upper left; LL, Lower left; LR, Lower right; I, Intrusion; E, Extrusion; B, Buccal; L, Lingual; M, Mesial; D, Distal.
Teeth with the significant intrusion or extrusion programmed in the ClinCheck are highlighted in this table. Alphabets used in Table 2 are tooth numbering.

3/16 inch, 4.5 oz; left side: 1/4 inch, 6 oz) were started throughout the first and second refinements. The patient developed centric interferences after the first refinement aligners due to hanging premolar palatal cusps caused by insufficient expression of planned buccal root torque during dental expansion in the upper arch. Additional buccal root torque was programmed in the second refinement for upper premolars to address the occlusal interferences (Figure 7). Asymmetric Class II elastics led to the significant forward movement of the left posterior segment assisted by IPR space in the lower arch and flaring of lower anteriors. As a result, a bilateral Class I molar relationship with 2 mm overbite was obtained in the second refinement. The final series of 30 aligners were used to achieve good posterior intercuspation and to improve the occlusion (Figure 7).

In the retention phase, the patient was asked to wear Essix retainers full time for the first 6 months, followed by Hawley's retainers with posterior bite block. A total of 117 trays were used in 3 refinements to finish the case (Figure 7). The patient's compliance was exemplary during the entire treatment duration. The overall treatment time was 3 years, and all the treatment objectives were fulfilled without any complication. Normal overjet and overbite were achieved with Angle's Class I molar relationship while maintaining the facial balance. Soft tissue profile was improved, and a consonant smile arc was achieved (Figures 8-14).

There was a 1 mm intrusion of maxillary molars and slight intrusion of mandibular molars, which caused the counterclockwise rotation of the mandible (Figures 6 and 7). This effect led to decreased Wits appraisal, increased the chin projection, increased the SNB angle, and decreased the lower anterior face height and angle of convexity (Figures 8-13). Regional superimposition of maxillary dentition showed intrusion and distalization of maxillary molar. Maxillary and mandibular incisors were extruded with the clear aligner treatment (Figure 14).

DISCUSSION

Management of skeletal open bite malocclusion in adults is often challenging with conventional treatment options. Mild to moderate open bite cases in Class II hyperdivergent and retrognathic patients can be successfully treated with mini-implants. Umemori et al.[10] used mini plates for the intrusion of mandibular posterior teeth, whereas Erverdi et al.[11] and Sherwood et al.[12] documented the correction of an open bite by the intrusion of maxillary molars with mini-implants placed in the infrazygomatic region.

Recently, the clear aligners have become popular, and clinicians are attempting to treat the open bite cases with aligners either in conjunction with mini-implants or standalone with aligners.[13] However, the comprehensive orthodontic treatment mechanics are generally extrusive for posterior teeth, leading to an increase in the mandibular plane angle, worsening the facial profile, and decreasing the overbite. To counteract these side effects, extensive extrusion of anterior teeth needs to be done to improve the overbite, comprising the long stability of attained results.

On the contrary, beneficial results are reported with aligner treatment of open bite subjects. Harris et al.[8] observed the amount

Figure 6. Intraoral progress photographs

of molar intrusion of 0.47 ± 0.59 mm and a reduction in SN-MP by 0.73 ± 0.94°, along with the decrease in SNB, Lower anterior facial height (LAFH), and favorable auto-rotation of the mandible. Although the amount of intrusion of posterior teeth was minimal based on the above study, the results are promising compared to comprehensive orthodontics. Mild to moderate open bite cases can be successfully corrected with clear aligner treatment, as documented by numerous case reports.[14] However, Garnett et al.[15]

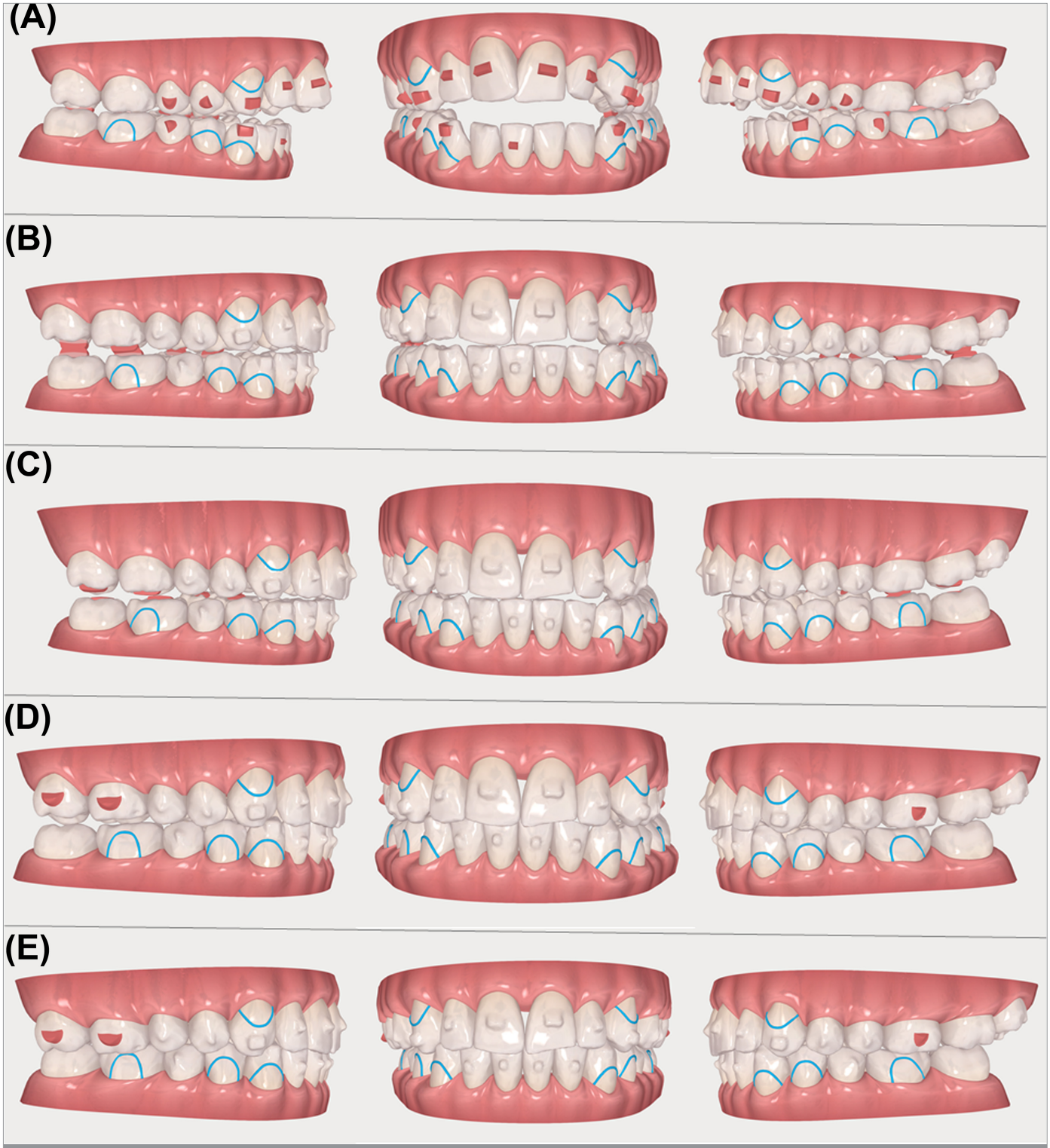

Figure 7. A-E. ClinCheck progress images (A: pretreatment, B: first refinement, C: second refinement, D: third/final refinement, E: final results)

compared the anterior open bite treatment between fixed appliances and clear aligner therapy, they did not find a significant difference in outcome between the 2 groups. The evidence is controversial regarding the effectiveness of aligners for the treatment of skeletal open bite. With the improvement in technology[16] and greater biomechanical understanding and the expertise of clinicians, complex vertical dimension malocclusion can be successfully treated as documented in this report.

The effectiveness of clear aligner treatment for various tooth movements has to be understood before treatment planning. This step is critical as overcorrections can be programmed in the ClinCheck to minimize the refinements, thereby increasing the efficiency of the appliance. In a recent study looking at the efficacy of tooth movement with Invisalign,[16] they found improved accuracy compared to a decade back. This was made possible by introducing smart force features that include

Table 3. Arch measurements programmed in ClinCheck Refinement 1

Arch Width (mm)				
Arch	**Teeth**	**Initial, Stage 1**	**Align Final, Stage 40**	**Difference**
Upper arch	UR3-UL3	29.1	32	2.9
	UR4-UL4	29.1	34.7	5.6
	UR5-UL5	32.7	37.9	5.2
	UR6-UL6	38.1	41.2	3.1
Lower arch	LR3-LL3	25.4	25.5	0.1
	LR4-LL4	27.8	28.9	1.1
	LR5-LL5	31.5	33	1.5
	LR6-LL6	37	37.1	0.1

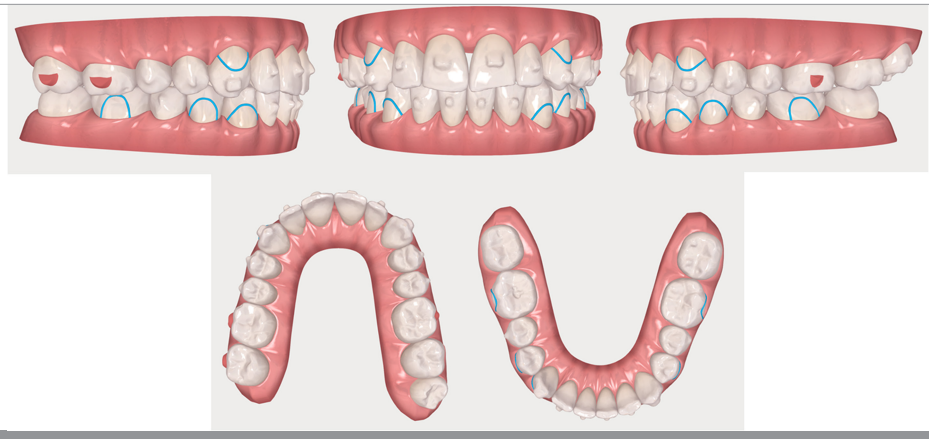

Figure 8. Final ClinCheck projection

Figure 9. Posttreatment photographs

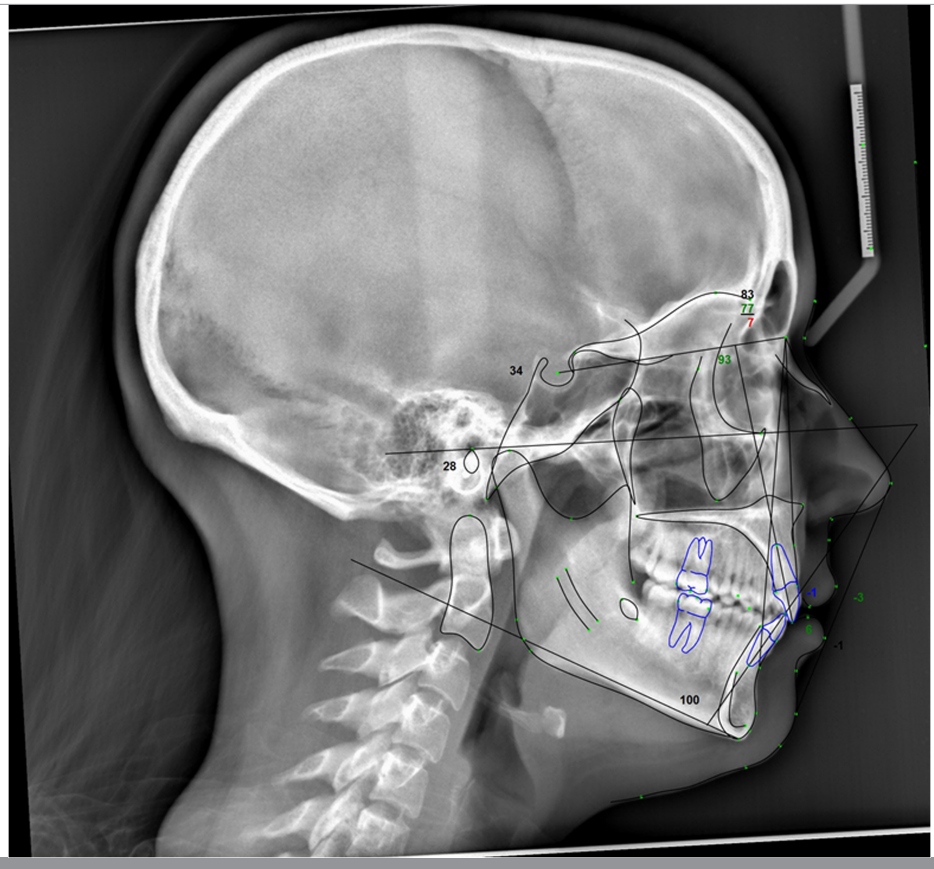

Figure 10. Posttreatment lateral cephalometric radiograph

Figure 11. Posttreatment panoramic radiograph

optimized attachments, pressure zones, customized staging, and SmartTrack aligner material, allowing a better working range and improved fit of trays. The accuracy was highest for buccolingual tipping (56%), whereas the intrusion of maxillary molar and incisor was at least 35% and 33%, respectively. To offset the drawback, overcorrection can be planned for the molar intrusion.

The clear aligners have a specific advantage for molar intrusion. The occlusal forces can be applied simultaneously along with the desired tooth movement since aligners entirely cover the occlusal surfaces. Also, the counterclockwise rotation of the mandibular due to molar intrusion will not interfere with the correction of the anterior open bite, as happens with the conventional braces.[17]

The patient in this report had a mild skeletal open bite with 5 mm of overbite and an overjet of 8 mm. The treatment was planned as recommended by Buschang et al.[4] who used mini-implants for posterior teeth intrusion, leading to the autorotation of mandible, which aided in the correction of skeletal and dental class

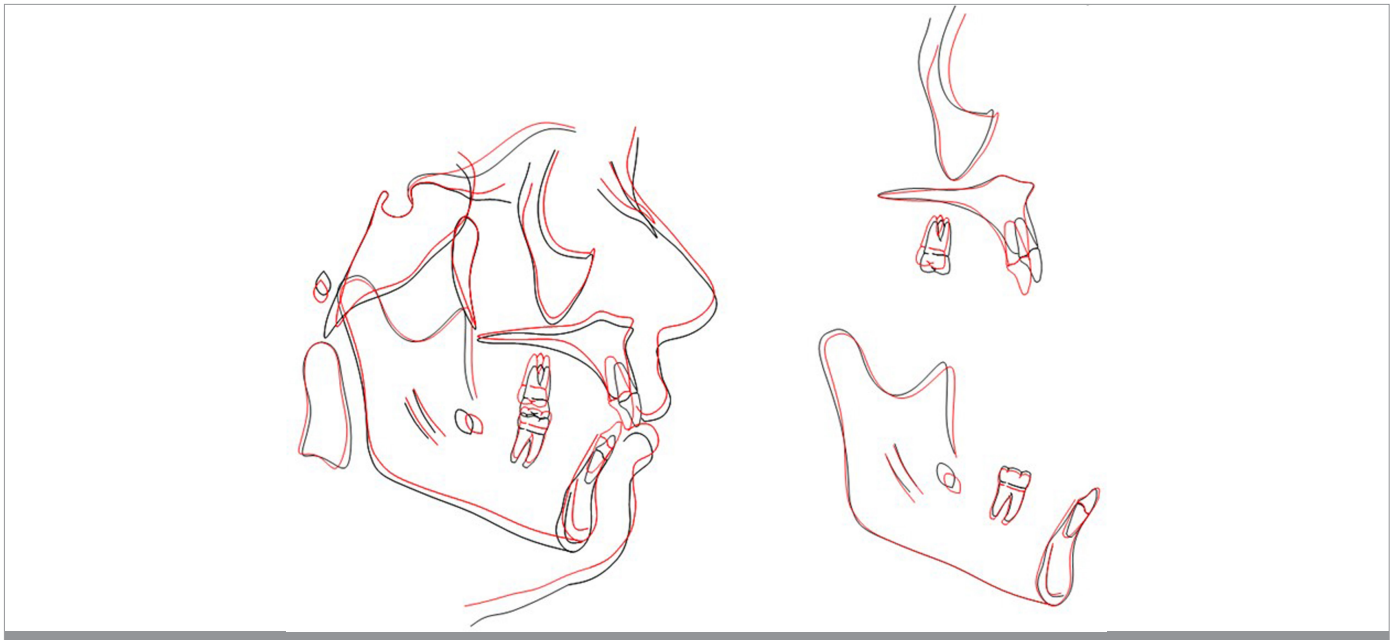

Figure 12. Superimposed lateral cephalometric tracings

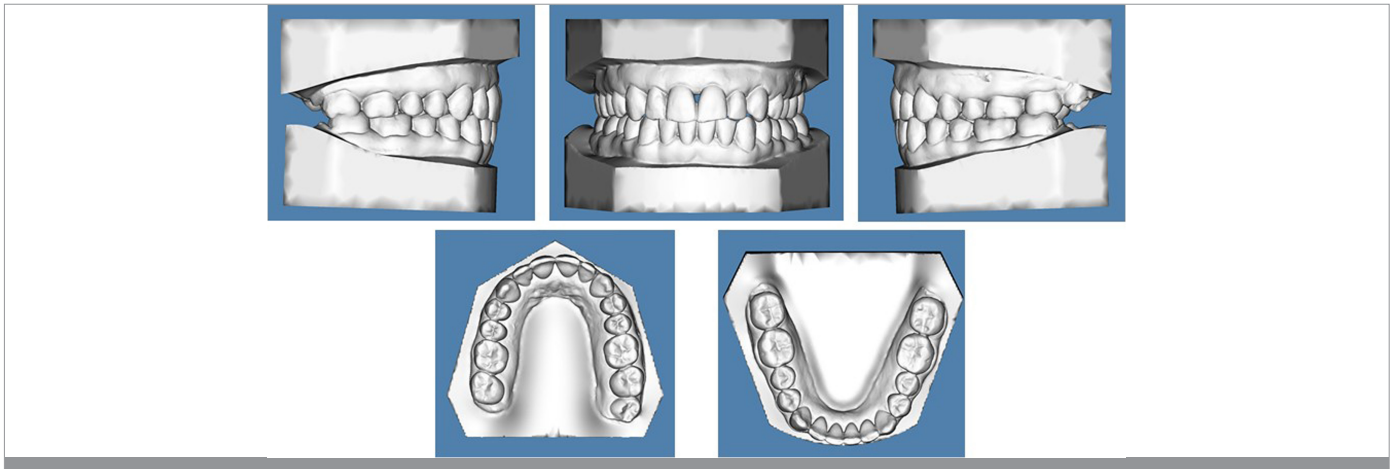

Figure 13. Posttreatment dental casts

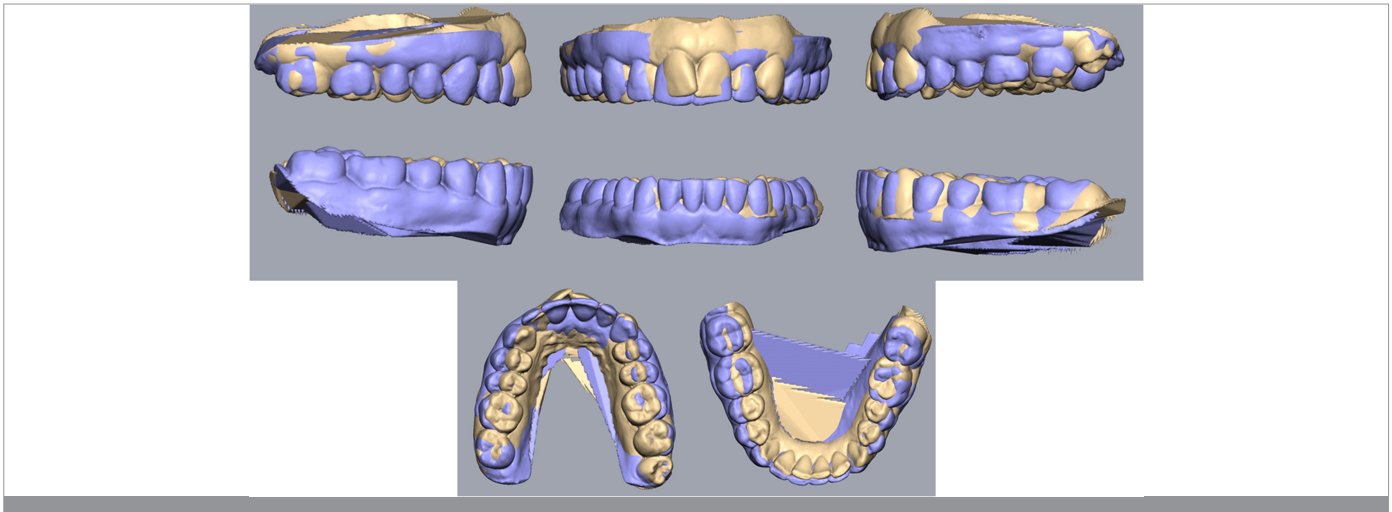

Figure 14. Superimposed dental casts

II relationships. However, we planned intrusion of maxillary and mandibular posterior teeth using clear aligners by having passive bite blocks of 5 mm thickness. Maxillary molar intrusion of 1 mm and slight intrusion of lower molars were achieved due to the bite block effect from raised clear aligner trays on posterior teeth and planned intrusion with aligner therapy in our patient (Figures 12 and 14). In the presented case, correction of the Class II molar relation could be due to a combination of the number of factors such as (1) the intrusion of posterior teeth caused counterclockwise rotation of the mandible, decrease in mandibular plane angle, a reduction in lower anterior facial height, and an increase in SNB angle, (2) derotation of the maxillary molars, (3) distalization of maxillary molars, (4) expansion of the maxillary arch, and (5) forward movement of the mandibular arch due to Class II elastics (Tables 1-3, Figure 10).

A meta-analysis reported that the success rates of both surgical and non-surgical approaches for the long-term stability of treatment of anterior open bites were greater than 75% (with an 82% mean stability value for patients surgically treated and 75% for patients treated only with orthodontics).[18] Relapse has been reported in 20-44% of conventionally treated patients.[19,20] Stability of anterior open bite correction using clear aligners has not been reported. Therefore, further research is needed for the long-term follow-up studies on open bite cases treated by clear aligner therapy.

CONCLUSION

Treatment planning with careful biomechanical consideration for open bite hyperdivergent patients with Angle's Class II molar relationship is crucial. Incorporating occlusal attachments on molars as bite blocks will help prevent vertical movement and apply intrusive forces on the posteriors. Furthermore, while correcting Class II molar relation using elastics, bite blocks can also help counter the side effects by preventing extrusion of the posteriors with Class II elastics.

With the improvements in the technology with clear aligner systems, mild to moderate skeletal open bite patients could be a treatment of choice, especially in adults. However, more research is necessary to develop protocols to achieve the results predictably.

Informed Consent: Written informed consent was obtained from the patient to publish her records including photographs as part of this case report.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.G., V.G., N.L.S., N.J.; Design – S.G., V.G., N.L.S., N.J.; Supervision – S.G., V.G., N.L.S., N.J.; Data Collection and/or Processing – S.G., V.G., N.L.S., N.J.; Analysis and/or Interpretation – S.G., V.G., N.L.S., N.J.; Writing – S.G., V.G., N.L.S., N.J.; Critical Review – S.G., V.G., N.L.S., N.J.

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Declaration of Interests: The authors have no conflict of interest to declare.

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