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Case Report

Clear aligner hybrid approach: A case report

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ABSTRACT

Introduction: This case demonstrates that hybrid application of clear aligners can be a rational and efficient approach for treating malocclusions, as compared with a clear aligner therapy alone option in which the magnitude of some movements would require a higher number of aligners and likely further refinement.

Treatment plan and progress: After a first successful orthopedic phase face mask + rapid maxillary expansion (FM + RME), a diagnostic digital setup of the second orthodontic treatment phase was performed, opting for an esthetic approach to make the treatment as fast and efficient as possible. After positioning lingual tubes on both arches, digital models were obtained and lingual archwires, passing through the previously positioned tubes, were simulated digitally. Then, a virtual setup comprising 10 steps for both arches was planned. Aligners enveloped fixed partial lingual appliances, improving patient comfort and efficiency of overall treatment. Aligners were changed every 7 days and the second phase of treatment was finished in 10 weeks with good occlusion and alignment in both arches. The entire treatment of the Class III patient was completed in 13 months of active therapy.

Conclusion: Combining clear aligner therapy and fixed lingual appliance is an esthetic means of treating malocclusions in a shorter treatment time with low costs and high efficiency.

1. Introduction

Nowadays, clear aligner therapy has become a viable treatment option for patients, especially adults, who request orthodontic treatment that will not negatively influence their social and personal sphere [1–3]. Indeed, one of the great advantages of clear aligners is that they are more aesthetic [4] and comfortable than traditional appliances [5], without impinging on facial esthetics or speech. Not only adults, but also growing patients between the ages of 8 and 16 have a strong self-perception regarding smile esthetics [6,7] and are, therefore, amenable to types of orthodontic treatment that involve the use of aesthetic appliances [8].

As regards the efficacy and efficiency of these types of appliances, clear aligner therapy is a good option for nonextraction cases of mild to moderate severity, displaying even more efficiency than fixed appliances in those cases [9]. However, clear aligners are less accurate when orthodontic movements are complex and generally less effective than conventional appliances in severe cases [10–12].

Although some types of movement are more difficult to achieve using aligners, the predictability and accuracy of clear aligner therapy seems to be closely linked to the quality of digital setup and careful patient selection [13]. Nevertheless, a recent meta-analysis has suggested that various auxiliaries are necessary to achieve satisfactory outcomes in many cases [10].

With this in mind, we describe here the case of a young patient whose second phase of treatment involved an innovative hybrid esthetic approach using clear aligners in conjunction with fixed partial lingual appliances. This approach increased the global efficiency of the treatment without a significant increase in costs.

2. Diagnosis and etiology

A 6-year and 5-month-old female patient presented to our attention complaining of an unsightly smile and requesting orthodontic treatment to align her anterior teeth. Extraoral assessment showed mandibular protrusion without facial asymmetry, in addition to poor exposure of the upper incisors on smiling and a predominant lower facial third at vertical analysis (Fig. 1).

The patient was in early mixed dentition with a tendency to dental Class III and an edge-to-edge incisor relationship with anterior open bite. Upper molars were rotated mesially, with an

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Fig. 1. Pretreatment extraoral photos of a 6-year and 5-month-old female. Her chief complaint was an unsightly smile and poor incisor display.

apparent improvement of the Class III molar toward a weak Class I molar relationship. Maxillary arch displayed no crowding and the mandibular showed a transient physiological malalignment. Moreover, the maxillary arch was v-shaped with reduced transversal dimensions, especially in the anterior part of the palate. Functional analysis revealed atypical deglutition and a low tongue posture. The gingiva had a thin biotype, which was readily appreciable in the mandibular incisor region (Fig. 2). The analysis of digital models confirmed clinical investigations (Fig. 3). Panoramic radiograph and cephalometric analysis confirmed skeletal Class III, normodivergence, protrusion of the upper incisors, and normal inclination of the lower incisors (Fig. 4).

Although the ANB (A point, nasion, B point) was within the norm (2.2°), the negative Wits value (−5.2 mm) and early age of the patient suggested a Class III growth pattern that could worsen at the subsequent growth peak (Table 1). No bone defects or temporomandibular joint alterations were recorded. Moreover, all teeth were present except for the upper and lower third molar buds (Fig. 4).

2.1. Treatment objectives

The treatment objectives were to solve skeletal Class III malocclusion, to obtain Class I canine and molar relationship, and to improve facial profile. The treatment plan comprised an initial orthopedic phase to achieve skeletal Class I relationship and positive overjet, and a subsequent orthodontic phase to achieve good occlusion and alignment in both arches.

2.2. Orthopedic phase

An initial orthopedic treatment phase was planned to achieve transversal expansion and protraction of the maxilla to counter and resolve the skeletal Class III. After 8-mm transverse expansion of the maxilla, achieved by means of a rapid palatal expander (1 turn per day for 40 days), a Petit orthopedic facemask (Lancer Orthodontics, Vista, CA), was prescribed to be worn for 12 to 14 hours per day (Fig. 5). After 11 months of active orthopedic treatment, both the profile and the incisor display had improved (Fig. 6). Intraorally, the Class III relationship had been normalized and the overjet and overbite increased. Despite some authors having described a counterclockwise rotation of the palatal plane after orthopedic facemask therapy, followed by worsening of the overbite [14], there was an improvement in incisor overlap in this case (Fig. 7).

Before proceeding to the second phase of treatment, we waited for all the permanent teeth to erupt to achieve good finishing of the occlusion. Once eruption had occurred, the patient was assessed for the final orthodontic phase with the aim of coordinating the arches

Fig. 2. Pretreatment intraoral photos of a 6-year and 5-month-old female exhibiting dental Class III malocclusion with poor anterior relationship.

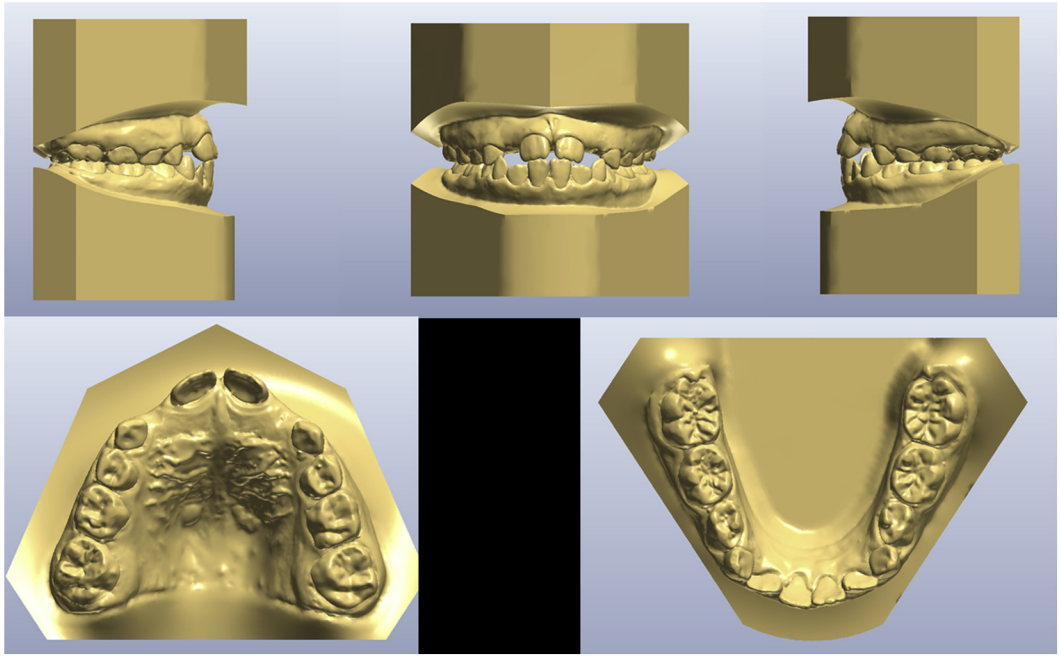

Fig. 3. Pretreatment digital models in different views.

and improving the occlusion. Extraoral analysis showed good maintenance of the profile during the eruption phase and an improvement in incisor display at smiling (Fig. 8). Intraoral examination showed bilateral molar and canine Class I, with positive overbite and overjet. There was slight crowding in the mandibular arch, and a greater degree of crowding in the maxillary arch, with hampered eruption of both maxillary canines (Figs. 9 and 10). Radiographs were taken 2 years from completion of the orthopedic phase to reevaluate the case before starting the second phase of treatment (Fig. 11). Cephalometric analysis, reflecting the results of both the prior orthopedic treatment phase and the physiological growth of the patient, showed a clear improvement in the Wits value (+2.3 mm), ANB (+2.7°), and SNA (sella nasion point A) (+4.5°) with respect to the pretreatment records, without modification of the vertical cephalometric values. The upper incisors were slightly proclined (+1.4°), whereas the lower incisors showed slight retroclination (−3.3°) (Table 1).

2.3. Orthodontic phase

2.3.1. Treatment alternatives

The second phase of treatment could have been carried out by means of nonextraction fixed vestibular appliances on both arches; however, following the patient's request to undergo orthodontic aligner treatment, which would be both aesthetic and efficient, we proceeded to perform a diagnostic digital setup to ensure the feasibility of this treatment option (Fig. 12). The correction values recorded for teeth 3.5 (rotation of 31°) and 2.3 (extrusion 2.15 mm and rotation 20°) were high; therefore, the treatment would involve the use of numerous sets of aligners and probably a further finishing phase. Hence, to adhere to the patient's request and make the treatment plan as efficient and uncomplicated as possible, we decided to use a hybrid approach involving both aligners (F22; Sweden & Martina, Due Carrare, PD, Italy) and fixed partial lingual appliances.

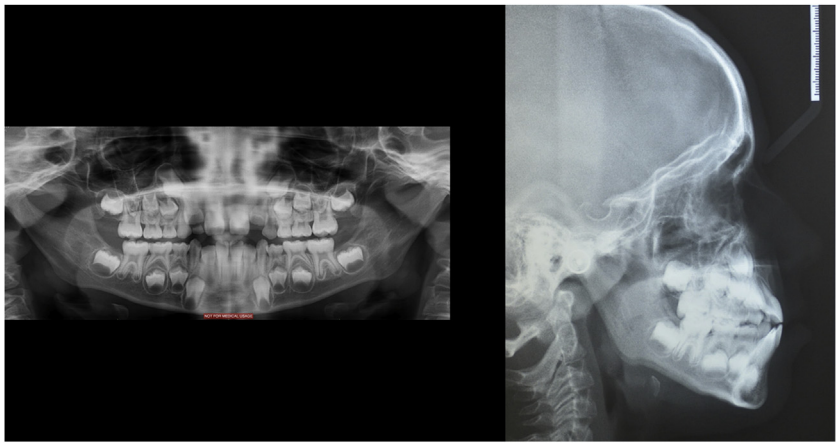

Fig. 4. Pretreatment radiographs of the patient.

Table 1
Cephalometric measurements from pre-treatment, pre-orthodontic second phase and post-treatment

Cephalometric measurements	Pre-treatment	Pre-orthodontic second phase	Post-treatment	Norm
Horizontal skeletal				
SNA	78.7°	83.2°	84.2°	82.0°
SNB	76.6°	79.4°	81.1°	80.0°
ANB	2.2°	4.9°	3.2°	2.0°
Maxillary skeletal (A-Na Perp)	0.9 mm	5.7 mm	5.6 mm	0.0 mm
Mand. skeletal (Pg-Na Perp)	−1.7 mm	2.0 mm	3.3 mm	−4.0 mm
Wits appraisal	−5.2 mm	−2.9 mm	−2.5 mm	0.0 mm
Vertical skeletal				
FMA (MP-FH)	26.1°	25.9°	24.8°	26.0°
MP–SN	38.5°	38.2°	36.5°	33.0°
Palatal-Mand Angle	24.2°	25.9°	23.5°	28.0°
Palatal-Occ Plane (PP-OP)	8.8°	8.8°	4.6°	10.0°
Mand Plane to Occ Plane	15.5°	17.1°	18.9°	12.2°
Anterior dental				
U-Incisor protrusion (U1-APo)	5.8 mm	7.2 mm	8.6 mm	6.0 mm
L1 protrusion (L1-APo)	5.9 mm	4.3 mm	6.2 mm	2.0
U1–palatal plane	116.0°	117.4°	122.7°	110.0°
U1–Occ plane	55.3°	53.8°	50.8°	54.0°
L1–Occ plane	64.4°	66.1°	63.0°	72.0°
IMPA	100.1°	96.8°	97.1°	95.0°

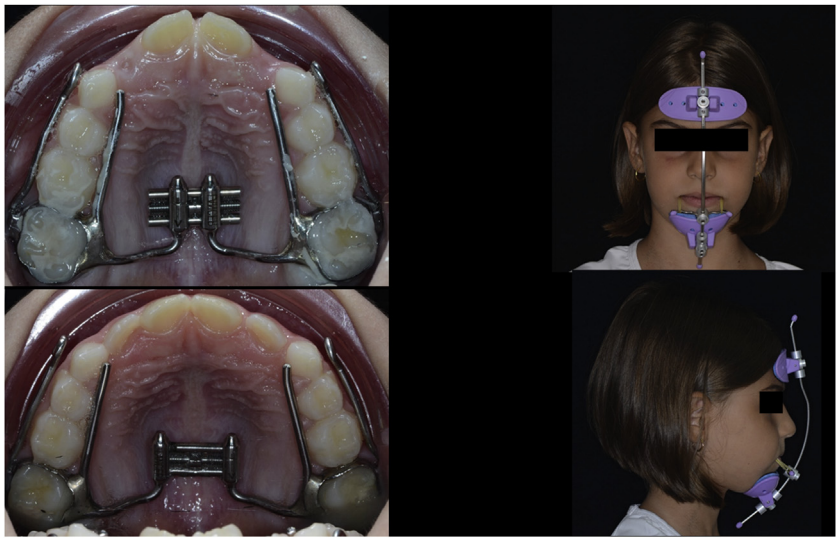

Fig. 5. First phase of orthopedic treatment with rapid maxillary 8-mm expansion (40 turns in total) and delivery of Petit facial mask.

Fig. 6. Post orthopedic extraoral photos show an improvement regarding profile and incisor display.

Fig. 7. Post orthopedic intraoral photos exhibit a normalization of Class molar, Class canine, and anterior relationship.

Fig. 8. Extraoral photos before orthodontic treatment.

Fig. 9. Intraoral photos before orthodontic treatment.

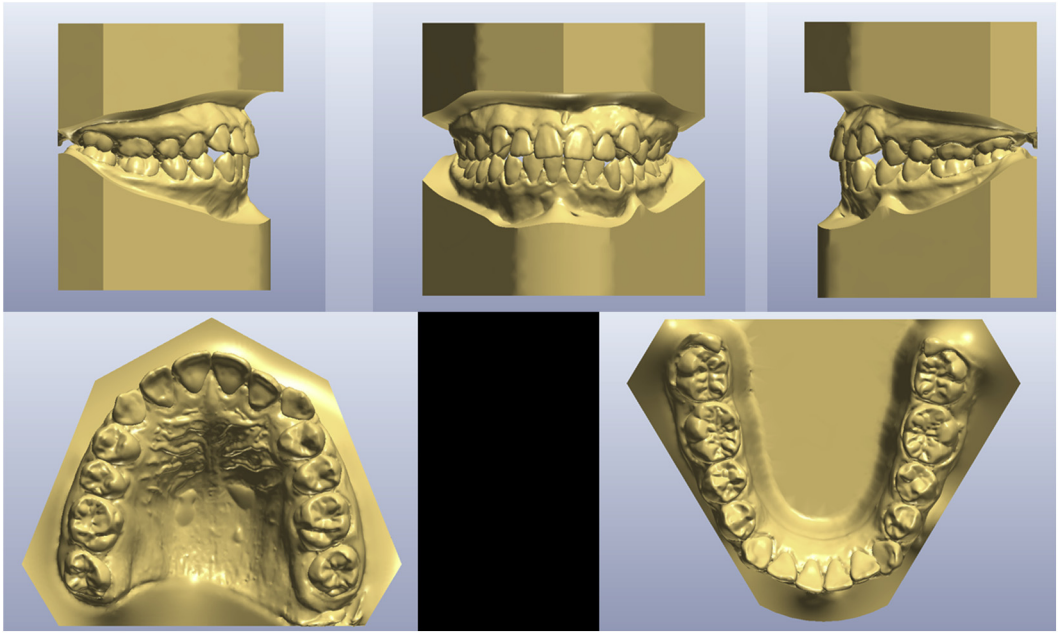

Fig. 10. Digital models before orthodontic treatment in different views.

2.3.2. Treatment progress

The first orthodontic intervention was to place lingual tubes on both the upper (teeth 22, 23, and 24) and lower (teeth 34, 35, and 36) arches (Fig. 13). Then, an accurate silicone impression was taken using the two-phase two-stage technique, thereby obtaining details from both the arches and positioning of the lingual tubes. Once the cast was obtained, it was digitized and a lingual archwire intersecting the previously positioned lingual tubes, was simulated using three-dimensional software (Fig. 14).

Simulating the presence of a lingual archwire in the setup allowed us to reproduce the space that would be physically occupied by fixed lingual appliances, thereby enabling the auxiliaries to be totally enveloped by aligners. The models were then appropriately segmented, and the treatment setup was performed.

Had we opted to use clear aligner therapy without the lingual auxiliaries, following a conventional staging protocol (2° of rotation and 0.25 mm of translational movements for each set of aligners), the treatment would have involved 20 steps in the maxillary arch and 16 in the mandibular. However, by omitting teeth 23 and 35 (whose correction would be assisted by the fixed partial lingual appliances) from the staging of the setup, the treatment time for the aligners was reduced to 10 sets of aligners in both arches.

During the aligner delivery appointment, vestibular grip points were created at the level of teeth 13, 15, and 33, as prescribed by the digital setup. These grip points served to facilitate the following planned movements: extrusion of tooth 13 (1.5 mm) and rotation of teeth 15 (14.7°) and 33 (20.3°).

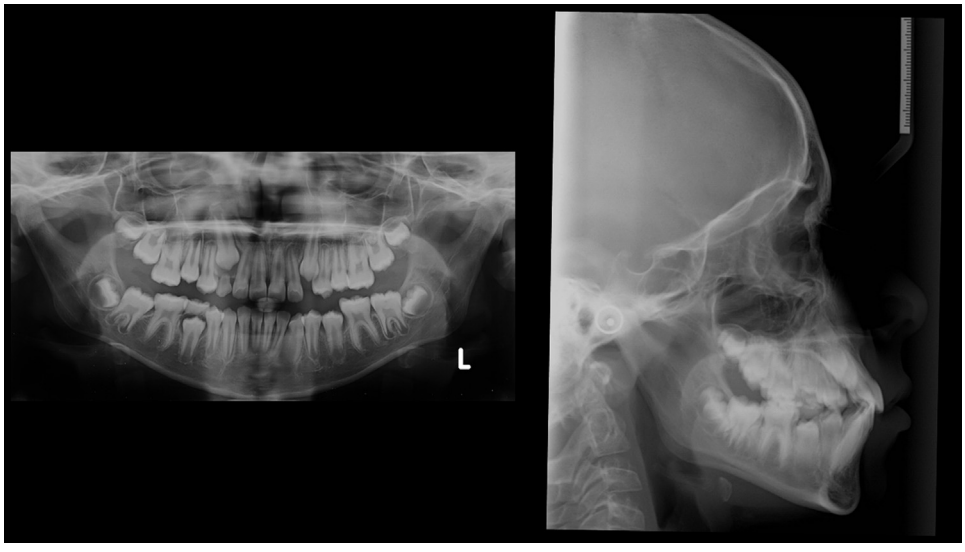

Fig. 11. Radiographs taken before the second phase of treatment. Cephalometric radiograph shows an improved intermaxillary relationship and good anterior relationship (overbite [OVB] and overjet [OVJ]) due to both previous orthopedic phases and physiological growth.

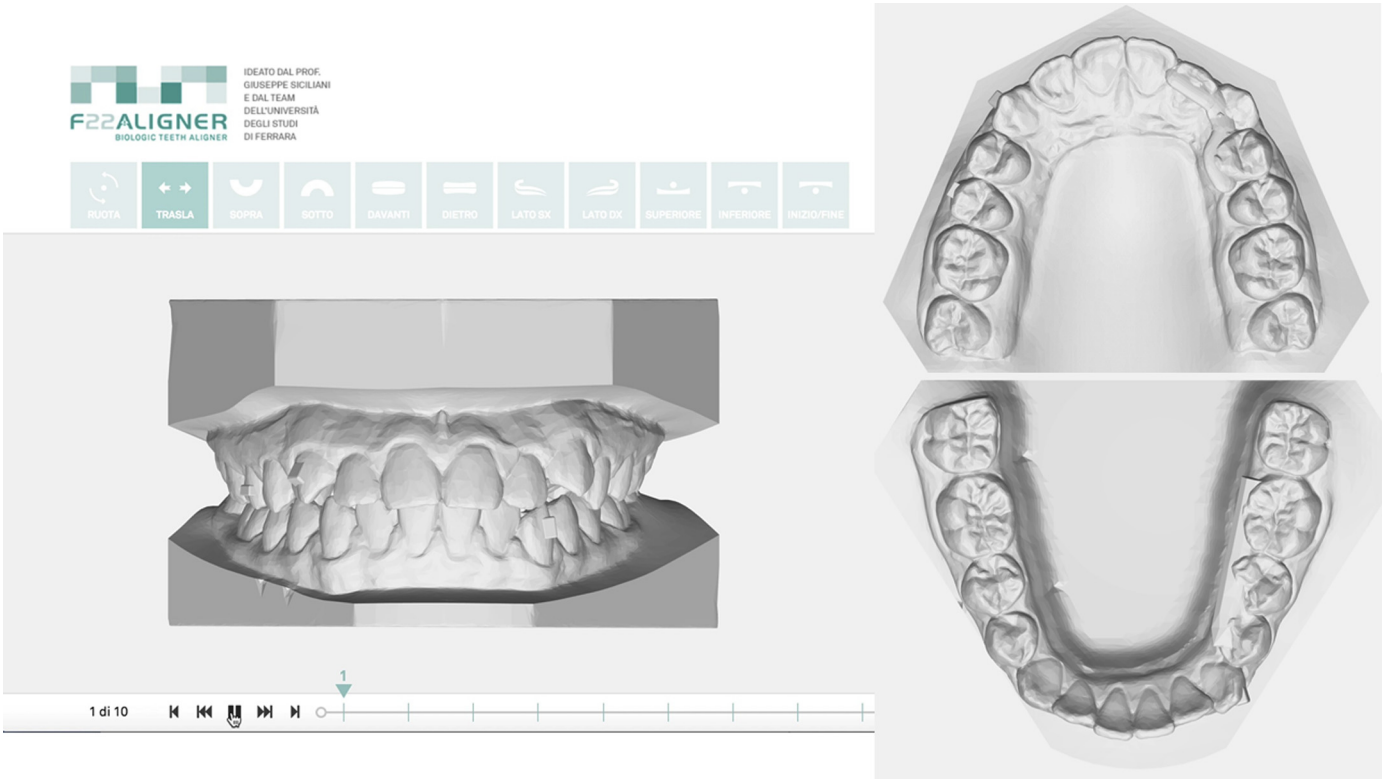

Fig. 12. Diagnostic digital setup to check the amount of orthodontic movement simulated. In the occlusal views the digital wire passing through the lingual tubes, simulating the lingual archwire, can be seen.

Next, a 0.016-inch nickel-titanium (NiTi) archwire was threaded in the mandibular arch and a 0.013-inch NiTi in the maxillary arch, at the level of the previously positioned lingual tubes and the aligners supplied.

The aligners completely enveloped the lingual sectional appliances, providing good comfort and outcome predictability (Fig. 14).

The patient was instructed to change aligners every 7 days, and to wear each for 22 hours per day. Meticulous stripping was performed gradually every 2 weeks to reach the amount prescribed.

Fig. 13. Application of lingual tubes directly before silicone impressions are taken.

The lingual sectional appliances were checked and reactivated as needed (Fig. 15).

2.3.3. *Treatment results*

After 10 weeks, the orthodontic phase of treatment was complete. The hybrid approach adopted had enabled achievement of the digitally planned outcome in only 2.5 months of treatment with only 10 sets of aligners. In the extraoral view, the profile was satisfactory and the smile esthetics had markedly improved (Fig. 16). Intraorally, bilateral molar and canine Class I was maintained, the values registered for overjet and overbite were good. Moreover, a functional anterior light contact was achieved and the upper and lower midlines were centered with the facial midline (Fig. 17). The malalignment and crowding had been solved and the arches were coordinated (Fig. 18). The leveling of the marginal crests in the posterior sectors was acceptable, despite a minimal discrepancy that could be detected between both 15 and 16 and first molars and second premolars in the mandibular arch (Fig. 19). Panoramic radiograph showed good root parallelism, although a slightly more radicular distal tip of both 32 and 42 could have been achieved. Posttreatment cephalometric analysis revealed excellent lower incisor control (+0.3°) and slight proclination of the upper incisors (+5.3°), as confirmed by superimposition of the radiographs (Fig. 20).

The orthodontic phase of treatment was completed through 10 steps in both arches, with the aligner being changed every 7 days. In this phase, the skeletal effects recorded are ascribable solely to the natural craniofacial growth of the patient, whereas tooth movements were generated by the orthodontic forces exerted by the aligners and fixed partial lingual appliances together (Fig. 21). The entire case was completed in 13 months of active orthopedic-orthodontic treatment, with an interim waiting period while eruption occurred.

Fig. 14. Intraoral occlusal photos after bonding lingual tubes and fitting aligners. Each aligner completely envelops the partial fixed lingual appliances, thereby reducing patient discomfort.

Fig. 15. Intraoral photos of aligners showing malocclusion improvement step by step.

Fig. 16. Final extraoral photos. Good profile is maintained and incisor exposure on smiling is corrected.

Fig. 17. Intraoral photos after orthodontic phase of treatment. Arches are aligned and leveled, molar and canine Class I has been achieved and overjet and overbite are good.

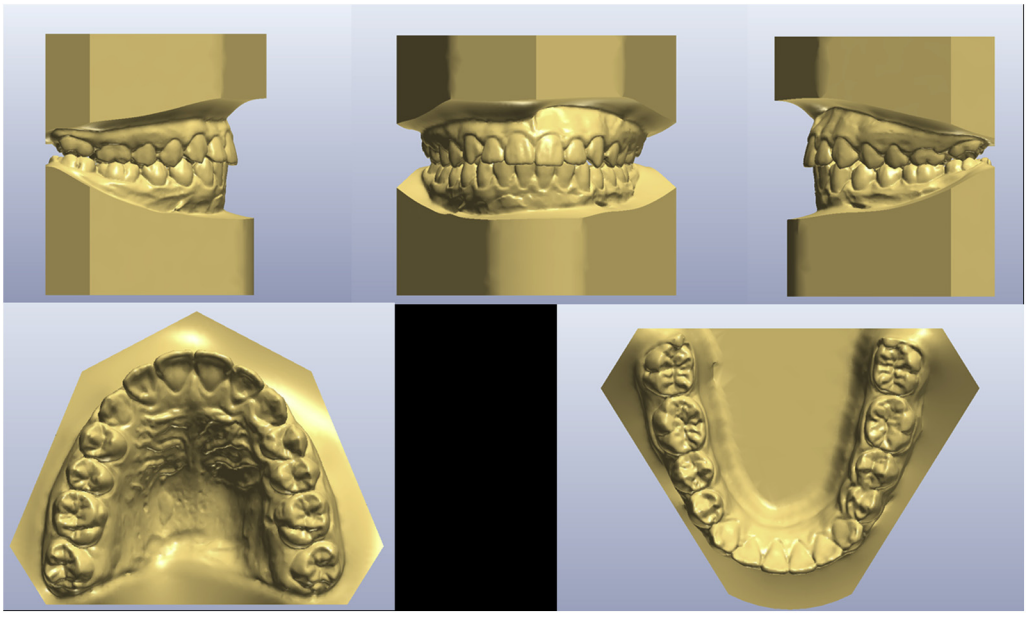

Fig. 18. Posttreatment digital models in different views.

Fig. 19. Marginal ridges of posterior teeth show an acceptable degree of leveling.

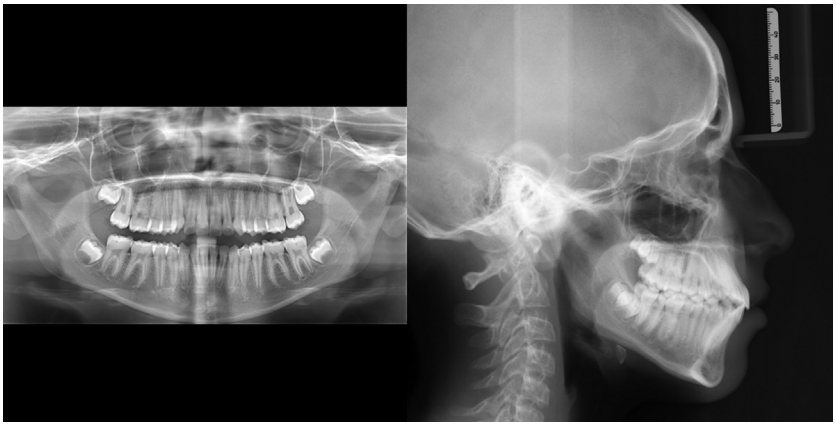

Fig. 20. Posttreatment radiographs showing acceptable root parallelism, no root resorption and improved skeletal Class relationship.

Cephalometric values recorded after the orthodontic phase are reported in Table 1.

As regards outcome stability, 1-year posttreatment records showed good maintenance of the results and even an improvement in the number and quality of posterior occlusal contacts, mainly due to spontaneous physiological settling (Figs. 22–24).

3. Discussion

Although clear aligner therapy was initially considered suitable for only nonextraction cases of mild to moderate severity [15], over time there have been considerable improvements in materials and treatment protocols, increasing the range of cases and malocclusion types that can be treated using this approach. Furthermore, new operating procedures designed to accelerate and facilitate orthodontic movement (vibration, photobiostimulation, and corticotomy) have been proposed [16–18], although these techniques considerably increase treatment costs.

Despite all the recent innovations, however, the literature is clear on the fact that some movements are achieved more efficiently than others. Although clear aligners seem to be more efficient than conventional appliances in treating cases of mild to moderate severity [9], extrusions, canine and premolar rotation, bodily movements and root torque remain difficult to achieve [10–12].

With this in mind, we developed and present here a hybrid approach that unites all the advantages of clear aligner therapy (esthetics [4], comfort and unhindered oral hygiene procedures [5]) with those of fixed lingual appliances (biomechanical efficiency and esthetics) [19], thereby reducing treatment times and keeping costs low. In this case, we opted for clear aligner therapy further to the patient's request, but the diagnostic setup revealed two critical biomechanical issues at the canines and premolars, namely the need for respective rotations of 31° and 20° of teeth 23 and 35, and 2.15 mm extrusion of the 23. In particular, tooth 23 would have to undergo two types of complex orthodontic movement (i.e., extrusion and rotation).

The use of aligners alone would have necessarily involved a considerable number of treatment steps, in addition to a high probability of needing to resort to a finishing phase or mid-course correction [20,21]. This would mean that treatment times would inevitably be considerably prolonged. Hence, we decided to use a hybrid treatment to draw on the strengths of both aligners and lingual appliances to provide treatment that would be efficacious, efficient, esthetic, and comfortable. The teeth that would have to undergo critical movements were bonded with lingual tubes and mounted with NiTi archwires (0.013-inch in the maxillary and 0.016-inch in the mandibular arch). These sectional appliances were completely covered by the aligners, thereby reducing the patient discomfort typical of lingual appliances [22].

In conjunction with the fixed appliances, the aligners guided the teeth into the planned positions in only 10 weeks, and the treatment was particularly efficient, without excessively increasing costs.

Despite the good results demonstrated in this case report, it is important to note that not all cases could be treated with this

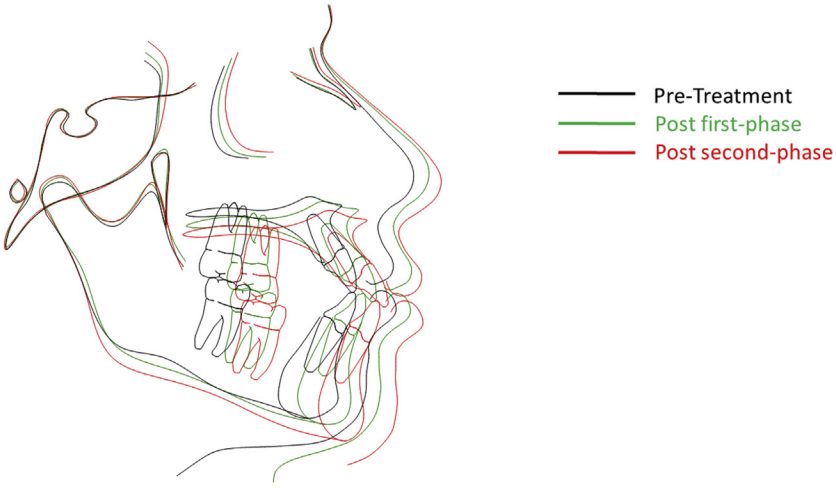

Fig. 21. Superimposition comparing pretreatment, preorthodontic (cephalogram acquired 2 years after orthopedic phase) and postorthodontic cephalometric tracings.

Fig. 22. Extraoral photos 1-year posttreatment.

Fig. 23. Intraoral photos 1-year posttreatment.

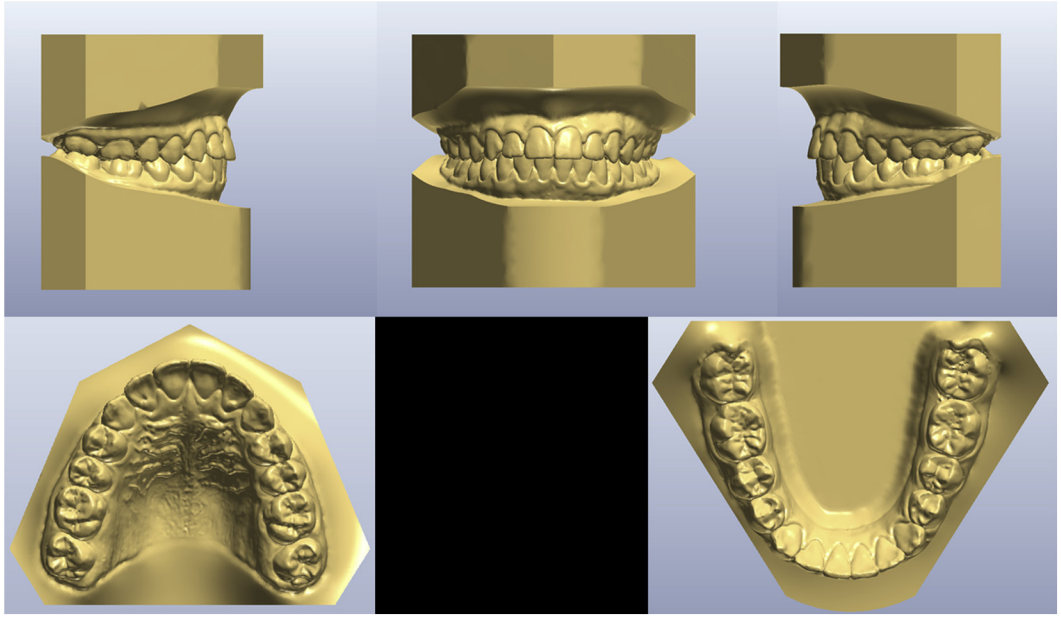

Fig. 24. Digital models 1-year posttreatment in different views.

biomechanical approach, and careful patient selection is required. For example, complex extraction cases need both substantial root control and good torque control in the anterior teeth during space closure, which should be guaranteed by a fixed appliance on all teeth and a full-size working stainless steel archwire with suitable stiffness. Moreover, this hybrid approach would not be a suitable option in malocclusions with severe deep or open bites (where considerable flattening of the Curve of Spee or substantial extrusion of anterior teeth must be achieved, respectively) due to the necessity of using complete fixed appliances in these cases as well.

That being said, we demonstrate that partial fixed lingual appliances can be used for certain movements (pure extrusions, severe rotations of rounded teeth, or radicular tip movements) in certain teeth as part of a hybrid approach that is effective, time-efficient, and designed to meet the esthetic demands of the patient.

4. Conclusion

Hybrid therapy using clear aligners and a partial fixed lingual appliance is an efficient and efficacious esthetic treatment option for certain cases involving some poorly predictable movements limited to certain teeth. Moreover, this approach significantly reduces overall treatment time without a marked increase in costs.

Acknowledgments

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