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Treatment of severe Class II skeletal malocclusion in a hyperdivergent adult patient via hybrid clear aligner approach: A case report of successful camouflage therapy

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Abstract

This case report describes the camouflage treatment of an adult patient with hyperdivergent facial pattern presenting with severe Class II skeletal malocclusion, through the use of a hybrid clear aligner approach, that relies on both a partial lingual fixed appliance and the continuous use of Class II elastics throughout therapy. After 11 months of treatment, the goals had been achieved, highlighting that the correct diagnostic framework, proper patient selection and careful digital planning of a compromise treatment can provide satisfactory aesthetic and functional outcomes.

Keywords

clear aligner therapy, hybrid aligner approach, Class II elastics

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Introduction

Currently, clear aligner therapy (CAT) is a valid treatment option, especially for patients, mainly adults, who require orthodontic treatment that does not adversely affect their social lives (Rosvall et al., 2009). Since their launch on the market, many studies have investigated both the effectiveness and efficiency of CAT (Charalampakis et al., 2018; Haouili et al., 2020); the literature agrees that these appliances are a good therapeutic option for non-extraction cases of mild–moderate difficulty, displaying even greater efficiency than conventional fixed appliances in such cases (Borda et al., 2020; Zheng et al., 2017).

However, they prove to be less efficient and effective than conventional fixed appliances in complex cases, such as extraction cases (Dai et al., 2019), and whenever control of root movements with torque, root tip or pure translation movements (Jiang et al., 2021) or significant modification of the dental overbite are required (Khosravi et al., 2017).

Some structural aspects of clear aligners (CAs), including their fit and retention capacity, in turn influenced by their thickness and gingival margin design, seem to be fundamental to obtaining adequate predictability of planned dental movements. In this regard, recent studies have shown that there is a difference, sometimes significant, between the various aligners systems on the market (Lombardo et al., 2020).

In addition to structural factors, the efficiency of CAT also seems to depend on the quality of digital planning, which must take into account orthodontic biomechanics and careful patient selection. Even with these precautions, however, some orthodontic movements remain difficult to achieve via CAs alone (Lombardo et al., 2017), prompting some authors to suggest the use of hybrid mechanics involving the simultaneous and synergistic use of partial fixed appliances, or other auxiliaries, and CAs. This strategy appears to make some corrections more predictable, such as pure extrusion, severe rotations of conical teeth and

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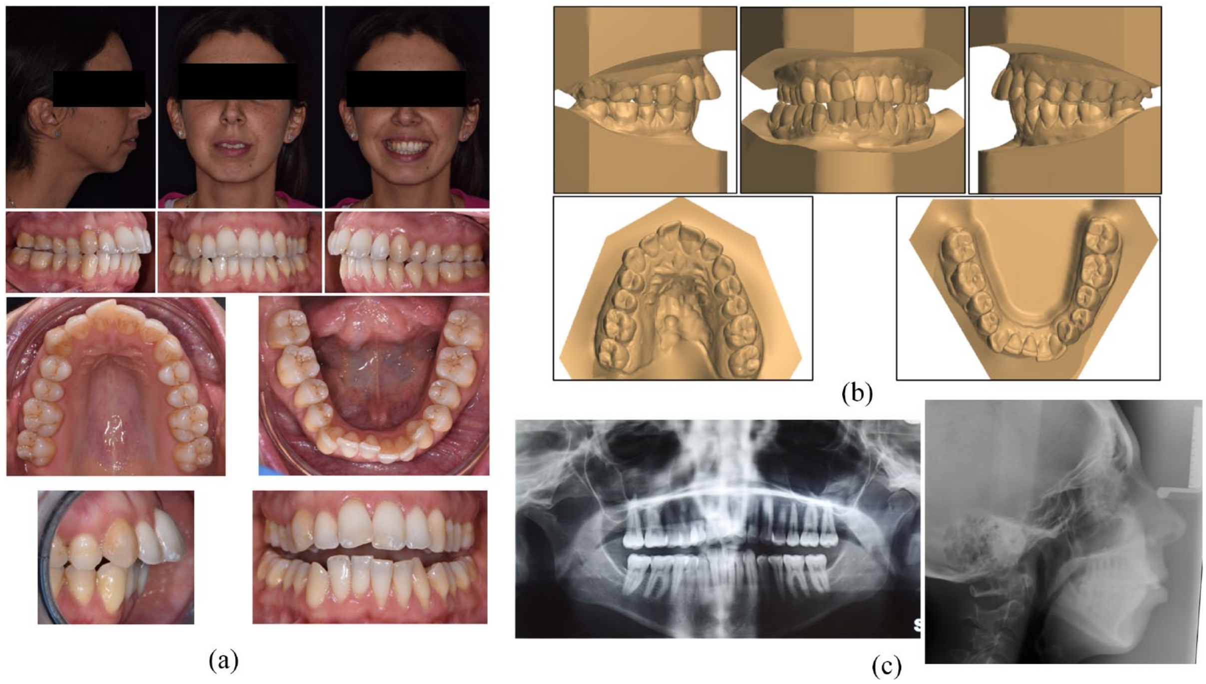


Figure 1. (a) Pre-treatment extra-oral and intra-oral photographs. (b) Pre-treatment digital models. (c) Pre-treatment cephalogram and panoramic radiograph.

root tipping movements (Lombardo et al., 2020; Palone et al., 2021).

Class II malocclusions are among the most common malocclusions in the adult population, amounting to about 23% of the total (Alhammadi et al., 2018); upon explicit request by the patient, this type of discrepancy is often treated with aligners and intermaxillary elastics. However, only those cases of limited sagittal discrepancy (2–3 mm) can be treated in this way (Ravera et al., 2016), considering that pure distalisation of the upper molars above the magnitude of 1.5–2.25 mm is very difficult to achieve (Ravera et al., 2016; Simon et al., 2014). Moreover, Patterson et al. (2021) have recently pointed out that anteroposterior correction programmed under conditions of significant sagittal discrepancy (Class II edge-to-edge relationship to full molar Class II) is poorly predictable with CAT, reaching only 6.8% of the prescribed correction, despite the continuous use of Class II elastics for about seven months. The authors concluded that this strategy entails the need for additional finishing aligners, thereby significantly increasing total treatment time (Patterson et al., 2021).

This case report shows that the correct diagnostic framework, proper patient selection and careful digital treatment planning can provide satisfactory aesthetic and functional outcomes in the camouflage treatment of an adult patient affected by severe Class II skeletal relationship with a hyperdivergent facial pattern. Specifically, the case report presented here details a compromise treatment involving a hybrid clear aligner approach (Lombardo et al., 2020; Palone et al., 2021) relying on both a partial lingual fixed appliance and the continuous use of Class II elastics throughout therapy.

Case reports

Diagnosis and aetiology

A 34-year-old female patient came to our attention complaining of an irregular smile and excessive prominence of the upper incisors, which, in her opinion, prevented her from easily sealing her lips. She reported a previous non-extractive orthodontic treatment with fixed appliances, refusing tooth extractions at that time.

An extra-oral examination showed a symmetrical ovoid face, with a predominant lower facial third. At rest, labial incompetence was evident, and when invited to seal her lips, the strain on the patient's chin muscle was observed. Upon smiling, the exposure of the incisors was good and the presence of augmented bilateral black corridors was evident, especially on the right side. The dental midlines were centred, but both diverged 2 mm to the left with respect to the facial midline. The profile was convex, the lower mandibular margin steep and the tendency of the patient to interpose the lower lip between the incisors is evident in this view (Figure 1a).

An intra-oral analysis revealed a Class II edge-to-edge molar relationship and full Class II canine bilaterally, with increased overjet and slightly decreased overbite. The dental midlines were coincident. The periodontal biotype was thin, with gingival recession at teeth 4.1, 4.2, 3.1, 3.2, 3.3, 3.4, 1.1, 2.2 and 2.3 (Figure 1a). As shown in, the overjet was remarkably large and the Spee curve accentuated (Figure 1a).

An analysis of the pre-treatment models showed moderate crowding in both arches (4.5 mm in the upper arch and 6 mm in the lower arch), while the degree of overjet amounted to 8.8 mm and that of the overbite to 1.1 mm. The Spee curve had a depth of 2 mm bilaterally (Figure 1b).

A cephalometric evaluation revealed skeletal Class II (ANB=10.9°; Wits=11.5 mm), with a mainly mandibular component (SNB=67°) and hyperdivergent skeletal pattern (FMA=38°; MP^SN=49°); the upper incisors were slightly proclined (U1^PP=117°), while the lower incisors were positioned normally (IMPA=96°) (Figure 1c and Table 1).

A panoramic radiograph revealed an accentuated distal root tip on tooth 1.1, and the presence of all teeth with the exception of the third molars. There were no bone defects or radicular resorption (Figure 6).

At functional testing, the patient presented no temporomandibular symptomatology or disfunction, despite being a female with a hyperdivergent facial pattern (Manfredini et al., 2016).

Treatment objectives

The primary treatment goals were those requested by the patient, namely to align both arches and to reduce the proclination of the upper incisors, in order to improve both lip competence and smile aesthetics. The secondary objectives were to obtain solid bilateral canine and molar Class I and establish correct overbite and overjet. A further goal was to improve facial aesthetics.

Treatment alternatives

Given the severe skeletal discrepancy, the first treatment option proposed was combined orthodontic-surgical treatment, involving the extraction of four premolars to make the arches coordinated and aligned. However, the patient refused this proposal, mainly due to the invasiveness of the treatment, which would require surgery be carried out under general anaesthesia.

Due to the degree of crowding, dental sagittal discrepancy and the patient's thin gingival biotype, fixed orthodontic therapy featuring the extraction of four premolars was considered. This type of treatment would not lead to a substantial improvement in profile, but would provide good occlusal results with good post-treatment stability and periodontium health. Nevertheless, this alternative was also rejected by the patient, who was not keen on either extraction or the use of fixed appliances, having already been treated previously with such appliance.

In line with her request for a more aesthetic approach, we elected to carry out a non-extractive orthodontic treatment with CAs, also considering the use of Class II elastics.

This approach would have a dual disadvantage, namely a lack of predictability of both the correction of the radicular tip on 1.1 (Jiang et al., 2021), and the resolution of the Class II relationship, given the extent of this discrepancy (Patterson et al., 2021). Moreover, the use of intermaxillary elastics would have an undesired effect, i.e. the proclination of lower incisors that in such case is not advocated considering the periodontium of the patient (Janson et al., 2013).

After discussing the above issues with the patient, it was decided by mutual agreement to use a hybrid aligner approach, which would make the correction of the radicular tip on tooth 1.1 more predictable. Despite the periodontal consideration, the resolution of sagittal discrepancy would be entrusted to the continuous use of Class II elastics, and the patient was warned that even with full compliance such a correction would be very difficult to obtain (Patterson et al., 2021), despite a mesial crown tip of the upper posterior teeth making this correction more predictable . The patient was made aware of the possibility of performing a gingival graft after treatment, if gingival recessions get worsen.

Aware of the limitations of this approach, the patient declared herself willing to undertake this therapeutic proposal, consisting of both a hybrid aligner approach and Class II elastics. She was aware that, with good probability, only a slight improvement in the dental sagittal discrepancy would be possible, however declaring that her priority was the resolution of crowding and the alignment of the anterior sectors.

This type of treatment has several biomechanical advantages, including anterior (Hennessy et al., 2016) and vertical anchorage control, which is particularly desirable in this kind of patients.

Digital planning

After taking PVS impressions (Zhermarck SPA, Badia Polesine, Rovigo, Italy) and obtaining digital models, a digital working set-up was performed simulating both sagittal and abnormal radicular tip on 1.1 resolution at the same time.

To achieve the latter efficiently, the position of the lingual metal buttons on the maxillary incisors was planned. Each button featured a 0.018-inch round hole (Sweden & Martina, Due Carrare, Padua, Italy), for the inserting of round wires, both NiTi and stainless steel (SS), up to a maximum diameter of 0.018 inch (Figure 2a).

To ensure sagittal correction, the digital planning involved dental movement in both arches in line with the

Table 1. Pre-treatment and post-treatment cephalometric measurements.

Measurements	Norm	Pre-treatment	Post-treatment
SNA (°)	82.0	78.0	76.1
SNB (°)	80.0	67.1	67.8
ANB (°)	2.0	10.9	8.3
Wits (mm)	0.0	11.5	8.7
Maxillary skeletal (A-Na Perp) (mm)	0.0	−1.3	−3.1
Mandibular skeletal (Pg-Na Perp) (mm)	−4.0	−24.1	−23.8
FMA (MP-FH) (°)	26.0	38.3	37.6
MP - SN (°)	33.0	49.1	48.3
Palatal-Mand angle (°)	28.0	40.7	40.3
Palatal-Occ plane (PP-OP) (°)	10.0	14.0	17.1
Mand plane-Occ plane (°)	17.4	26.7	23.8
U1-APo (mm)	6.0	12.7	8.1
L1 - APo (mm)	2.0	3.8	5.0
U1 - Palatal plane (°)	110.0	116.7	100.8
U1 - Occ plane (°)	57.5	49.3	62.1
L1 - Occ plane (°)	72.0	56.7	52.0
IMPA (°)	95.0	96.6	104.2
Upper lip (mm)	−4.0	−1.7	−1
Lower lip (mm)	−2.0	6.7	4.9

biomechanical effects of Class II elastics, one-third being characterised by bodily movements and two-thirds by crown movement (Janson et al., 2013). No sequential distalisation was programmed for the upper molars.

In order to maximise the biomechanics of this correction, vertical rectangular grip points were placed on the upper first molars and teeth 1.4 and 2.5, while in the lower arch stability grip points were placed at the level of teeth 3.7, 4.4 and 3.7, and those with the dual purposes of derotation and stability on teeth 3.4 and 3.5. The strategic positioning of these latter grip points allowed slight intrusion of the first molars to be planned to counteract the extrusive force of the Class II elastics on these teeth (Janson et al., 2013). In addition, derotation grip points were applied at the level of teeth 2.3, 3.3 and 4.3, as the correction of such conical teeth exceeded the critical threshold of 15° (Kravitz et al., 2008).

The crowding in both arches was to be solved by the planning of a significant amount of enamel interproximal reduction (IPR): in the upper 0.3 mm from mesial 1.5 to mesial 2.5, and in the lower 0.4 mm from mesial 3.5 to mesial 4.5. The greater amount of IPR in the lower arch had the aim of avoiding excessive proclination of the lower incisors and planning a lingual crown tipping to counteract Class II elastics effect.

The treatment planning was composed of 12 steps in both arches, without taking into account the radicular tip correction on 1.1, which instead was entrusted to the partial fixed lingual appliance.

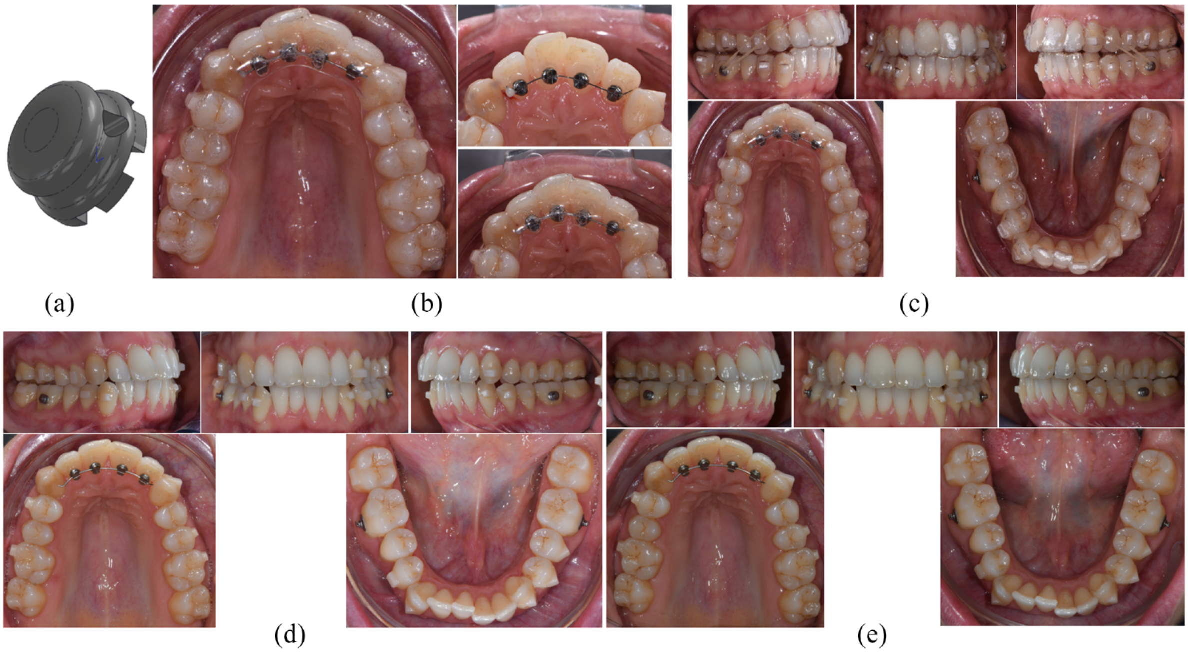
Treatment progress

Before the delivery of the first two aligners (F22 Aligners; Sweden-Martina, Due Carrare, Italy), vestibular grip points (Gradia Direct LoFlow; GC Orthodontics Europe GmbH, Breckerfeld, Germany) and lingual metallic buttons to the upper incisors were performed, and a 0.010-inch NiTi archwire inserted. This system was completely encased by the aligners to reduce patient discomfort (Figure 2b).

The patient was instructed to wear CAs for about 22 h per day, and replace them every 14 days.

After the first two weeks, two vestibular metallic buttons were placed on 3.6 and 4.6, and Class II elastics (6.5 once, 3/16” to be worn for 22 h/day) were delivered (Figure 2c), alongside the second pair of CAs.

Figure 2. (a) A metallic lingual button. (b) Intra-oral occlusal photos after bonding metal lingual button with 0.010-inch NiTi wire. The aligner completely envelops the system. (c) Application of aligners No. 2 and Class II elastics. (d) Delivery of aligner No. 5, with a 0.014-inch NiTi archwire. (e) Delivery of aligner No. 8, with a 0.016-inch NiTi archwire.



Eight weeks after the start of treatment, a 0.014-inch NiTi archwire was inserted, and aligners No. 5 were delivered (Figure 2d).

After a further six weeks of therapy, the archwire was replaced by a 0.016-inch NiTi, and the patient was provided with aligners No. 8 (Figure 2e).

Then, about five months after delivery of the first aligners, a 0.018-inch NiTi archwire was applied in order to finalise the radicular tip correction on tooth 1.1; then, the patient received aligners No. 10 (Figure 3a).

Before the delivery of the last couple of CAs, a slight misfitting at the level of the mandibular arch was observed; for this reason, lower aligner No. 11 was kept in place and cut to house an auxiliary elastic chain stretched on two lingual metal buttons to derotate tooth 4.3; meanwhile, upper aligner No. 12 was to be delivered (Figure 3b).

Lower aligner No. 12 was delivered after approximately two weeks, with an extrusive elastic (6.5 once and 3/16”, to be worn for 22 h/day) that was applied to both an aesthetic vestibular and metallic lingual button on tooth 4.3; then, this aligner was trimmed properly to fit around this new auxiliary (Figure 3c).

The first phase of CAT was completed in about 26 weeks (Figs. 3d and 4a), and was followed after one month by a further finishing phase.

The second phase consisted of five pairs of CAs to refine the alignment of the lower arch and improve arch coordination. In this phase, Class II elastics were applied directly to the aesthetic buttons positioned on the upper canines to promote their extrusion. The lingual buttons on the upper incisors level were kept in place during this phase to promote stabilisation of both results and upper CAs. In addition, to promote midline centring and achieve good molar and canine Class I, the use of full-time Class II elastics on the right, and only at night on the left, was prescribed (Fig. 4b, c); these were to provide greater expansion with vestibular dentoalveolar tipping in the posterior sectors of the first quadrant in order to counteract the contraction of the upper arch provoked them. This second phase was completed in a further 10 weeks of therapy (Figure 4d).

Treatment results

After only 10 months of treatment, the therapeutic goals had been achieved. The extra-oral photos revealed an improvement in lip competence, although this had not been completely solved, and good concordance of the smile line with the lower lip, as well as a reduction of the buccal black corridors (Figure 5a). The intra-oral photos showed excellent occlusal outcomes, with bilateral molar and canine Class I relationships, overjet and overbite within the norm, centred midlines and good anterior light contact (Figure 5a). Posterior marginal ridges were well levelled (Figure 5a). The gum recession noted at the beginning of treatment had not been exacerbated. The vestibular buttons on the lower first molars

Figure 3. (a) Delivery of aligner No. 10, with a 0.018-inch NiTi archwire. (b) Delivery of upper aligner No. 12 and lower aligner No. 13, with rotational auxiliary for 4.3. (c) Delivery of lower aligner No. 12 and elastic chain auxiliary for extrusion of 4.3. (d) End of first phase of therapy.

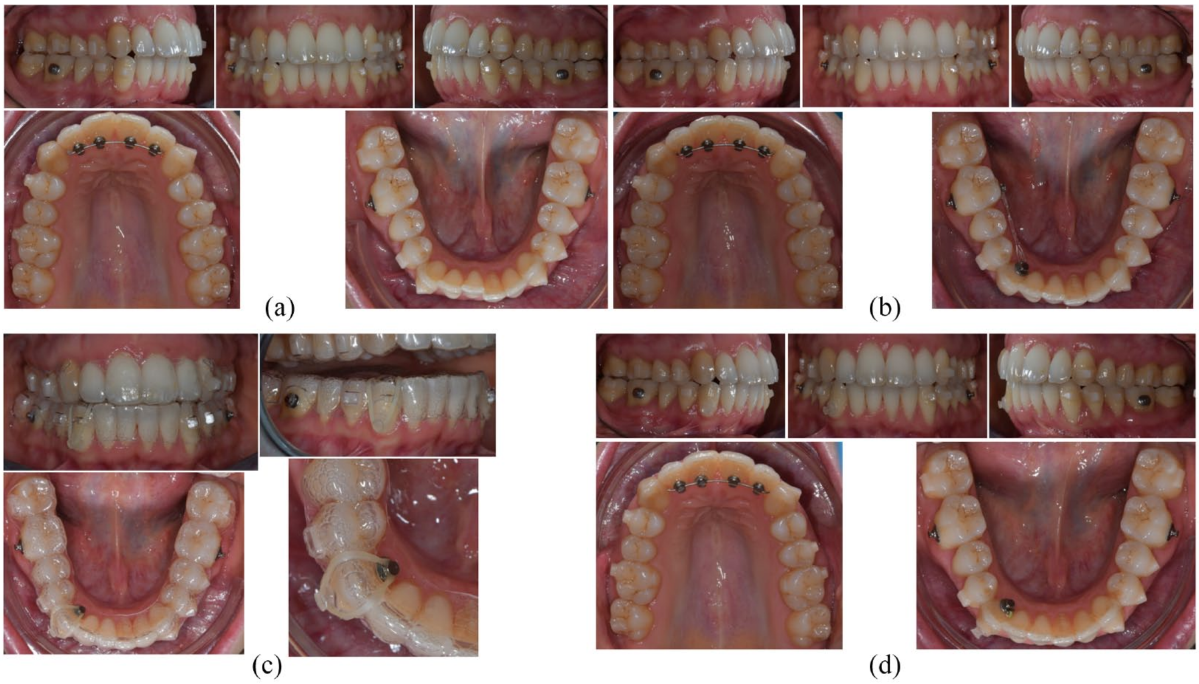


Figure 4. (a) End of the first phase of therapy with aligners worn. (b) Delivery of finishing aligners No. 1. (c) Delivery of finishing aligners No. 1 with aligners worn. (d) Delivery of finishing aligners No. 5.

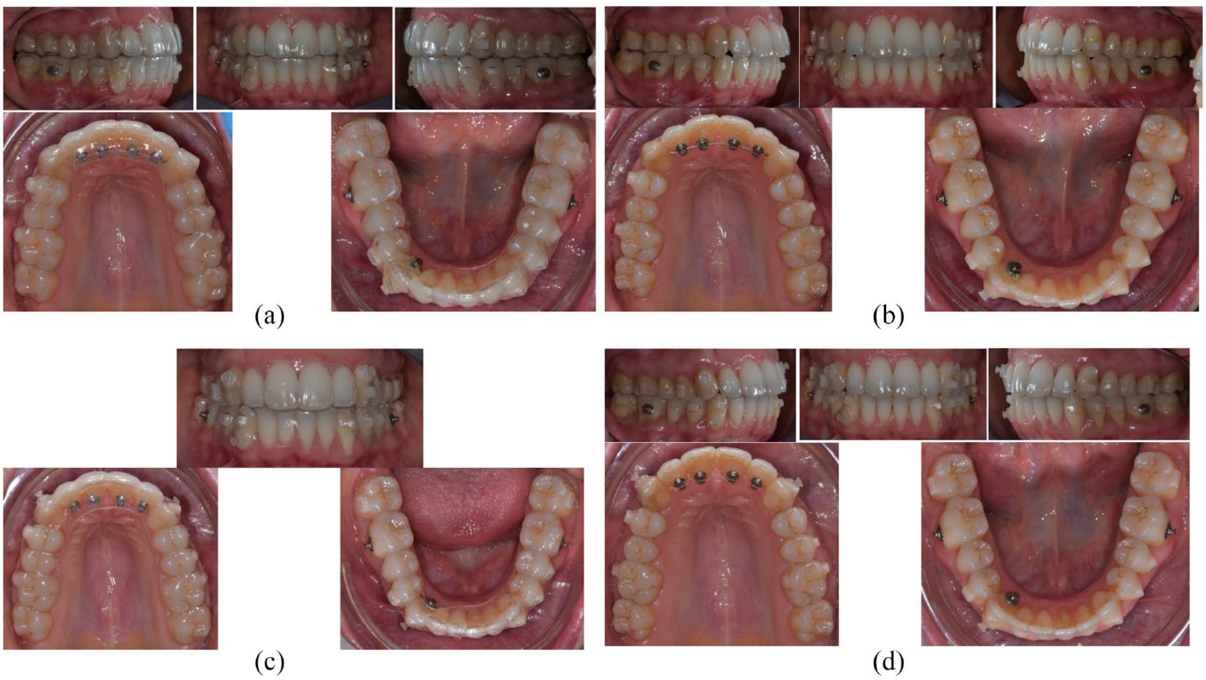
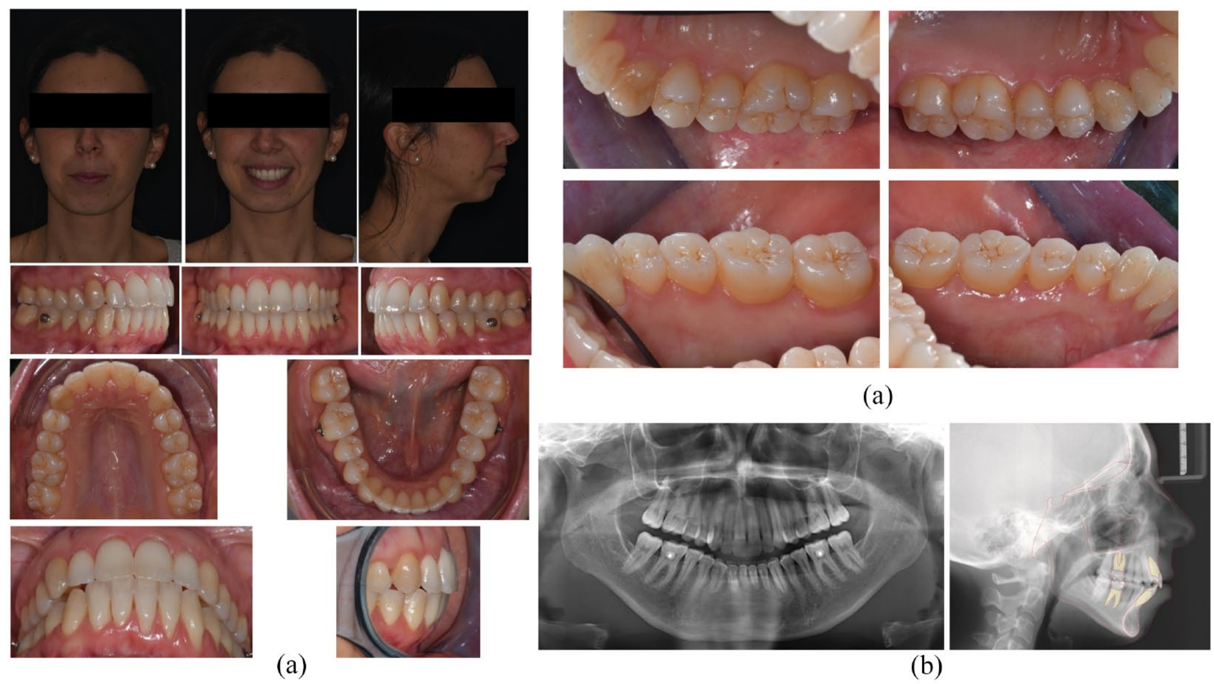


Figure 5. (a) Post-treatment extra-oral and intra-oral photographs and levelling of posterior marginal ridges. (b) Post-treatment cephalogram and panoramic radiograph.



had been left in place to allow the nocturnal wear of Class II night elastics during the first four months of retention, and their progressive reduction to alternate night wearing during the first year of retention. The retention protocol is based on the full-time use of removable thermoplastic contention due to the camouflage nature of the treatment.

The post-treatment cephalometric values showed an import dental compensation of the underline skeletal Class II (ANB=8.3°; Wits=8.7°). A slight counterclockwise rotation of the mandibular plane (FMA=37.9°), a reduction in the upper incisor inclination (U1^PP=100.8°) and accentuated proclination of the lower incisors (IMPA=104.2°) were seen (Figure 5b and Table 1). A post-treatment panoramic radiograph showed good root parallelism without signs of root resorption and bone defects (Figure 5b)

The cephalometric tracing superimposition confirmed the changes described above (Figure 6a(A)). In the upper jaw, a clockwise rotation of the occlusal plane was evident, characterised by both distal coronal tipping and slight intrusion of the upper first molars, while retroclination of upper incisors occurred (Figure 6a(B)). In the lower jaw, the occlusal plane followed the maxillary occlusal plane, with minimal extrusion and mesialisation of the first molars and proclination of the incisors (Figure 6a(C)). The planned intrusion at the level of the first molar effectively counteracted the extrusive component from the Class II elastics, while the extent of the mesialisation of the lower molars was greater than the linear advancement of the lower incisors, thanks to the good amount of IPR performed (Figure 6a). The occlusal plane clockwise (+6°) and mandibular counterclockwise rotation (−1°) could be appreciated in Figure 6a(A–E). While the former was a pure dentoalveolar effect, the latter was a positional change, favoured in turn by the improved posterior occlusal gear (passing from Class II edge-to-edge molar relationship to Class I molar relationship) and by limiting the side effects of continuous wearing of Class II elastics.

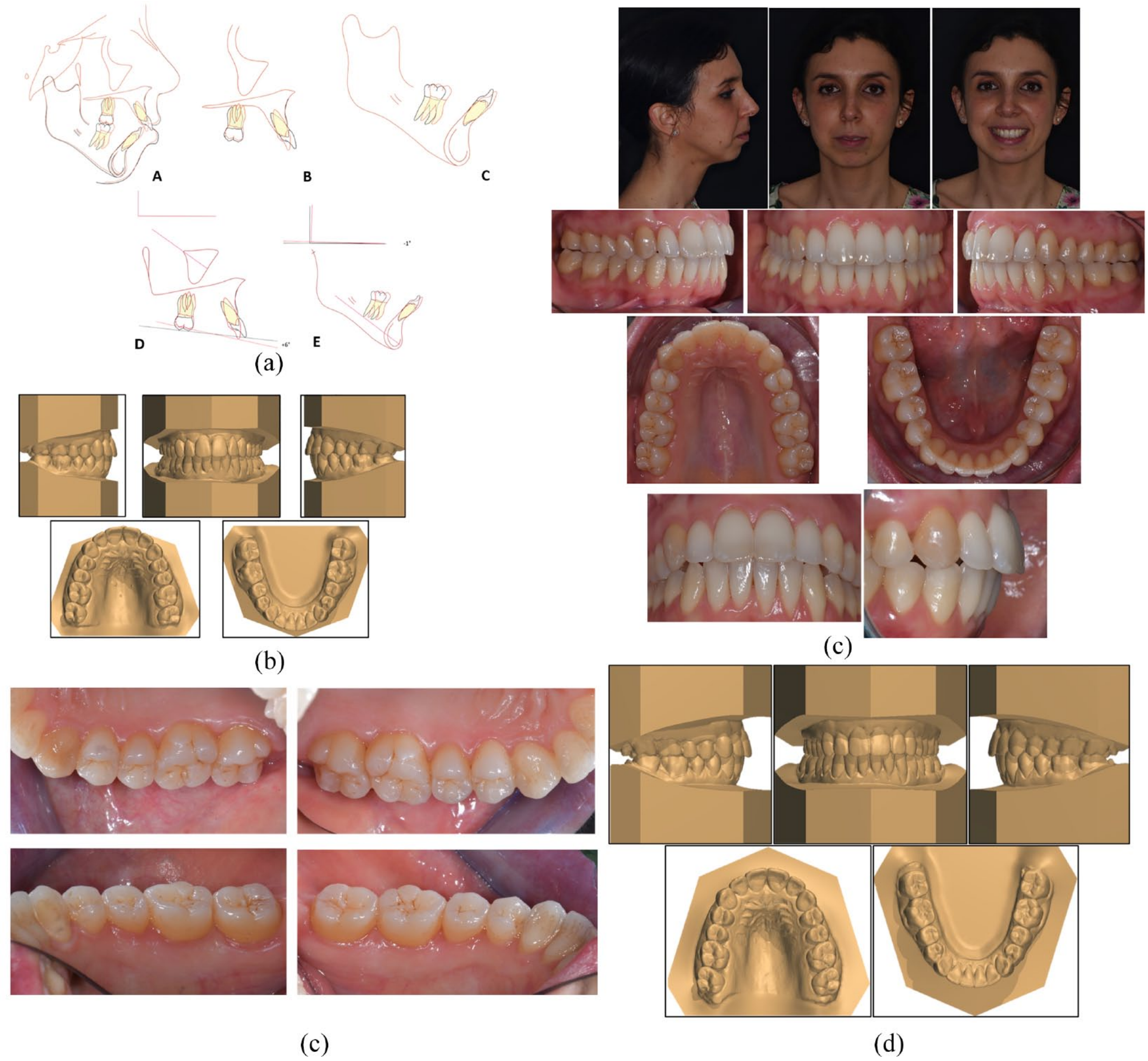
The post-treatment digital models showed that a good occlusion was achieved (Figure 6b).

One year after the end of therapy, the therapeutic results have been maintained (Fig. 6c), although a slight relapse of overjet could be observed (Fig. 6d). It should be noted that the periodontal status has not worsened.

Discussion

Despite major marketing campaigns by the aligner manufacturers (Gierie, 2018), this type of appliance has clear and proven biomechanical limitations (Zheng et al., 2017). In fact, although the range of malocclusions that can be treated using aligners has broadened of late, some clinicians have proposed the use of hybrid aligner approaches for complex cases (Lombardo et al., 2020; Palone et al., 2021). The hybrid CA approach used in this

Figure 6. (a) Superimposition of tracings. Cranial base (A), maxillary (B) and mandibular (C) superimposition. Occlusal plane clock-wise rotation (D) and mandibular counterclockwise rotation (E). (b) Post-treatment digital models. (c) Extra-oral and intra-oral photographs one year after treatment. (d) Digital models one year after treatment.



case report made it possible to correct efficiently the abnormal root tip on tooth 1.1.

Some authors have proposed various methods of facilitating and accelerating orthodontic movement, including vibration (Bowman, 2014), photobiostimulation (Ojima et al., 2016) or corticotomy (Cassetta et al., 2016), but this increases the costs of treatment. In contrast, the hybrid approach used here was efficient and did not entail a substantial increase in costs, and in fact reduced overall treatment time.

For instance, Class II malocclusion conditions can vary in difficulty from edge-to-edge (4 mm) to full Class II (8 mm), and cannot be solved predictably using aligners despite the continuous use of Class II elastics and sequential planned movement of the upper molars (Patterson et al., 2021)

In this case, the sagittal correction was obtained through pure dentoalveolar compensation, favoured by the excellent compliance demonstrated by the patient and likely the fact that her hyperdivergent skeletal pattern facilitated dentoalveolar movement, due to the reduced cortical thickness typical of subjects with increased verticality (Gaffuri et al., 2021). In addition, this correction was facilitated by the pre-treatment mesial crown tipping of the upper posterior teeth.

Due to the patient's hyperdivergent skeletal pattern, lower first molar intrusion was planned to counteract their extrusion induced by the full-time use of Class II elastics (Janson et al., 2013) and, moreover, the aligner thickness also helps this vertical control. This prevented the unwanted opening of the bite, resulting in a slight clockwise rotation of the jaw after the obtaining of a good occlusal gear. Moreover, since proclination of the lower incisors is among the adverse effects reported for extensive use of Class II elastics, our orthodontic CA series and a great amount of IPR in the lower arch were planned to limit this aspect. Despite this foresight, at the end of treatment, the lower incisor proclination was not inconsiderable, although probably less than would have resulted had conventional fixed appliances been used (Hennessy et al., 2016).

Finally, the slight counterclockwise mandibular rotation, favoured in turn by the excellent vertical control, guaranteed by both the aligner's thickness and careful digital planning, and by improving of posterior occlusal gear (passing from Class II edge-to-edge to Class I molar relationship) actively contributed to the improvement in sagittal dental relationships. Furthermore, in spite of the extent of the correction performed, no adverse periodontal effects were detected at either the gum or roots with good overall stability one year after the end of therapy.

Conclusion

The present case report shows how good patient selection, accurate digital planning and the use of hybrid aligner approach involving the use of both Class II elastics and a partial lingual fixed appliance manage to provide a satisfactory occlusal result with excellent vertical and occlusal control within a reasonable timeframe.

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