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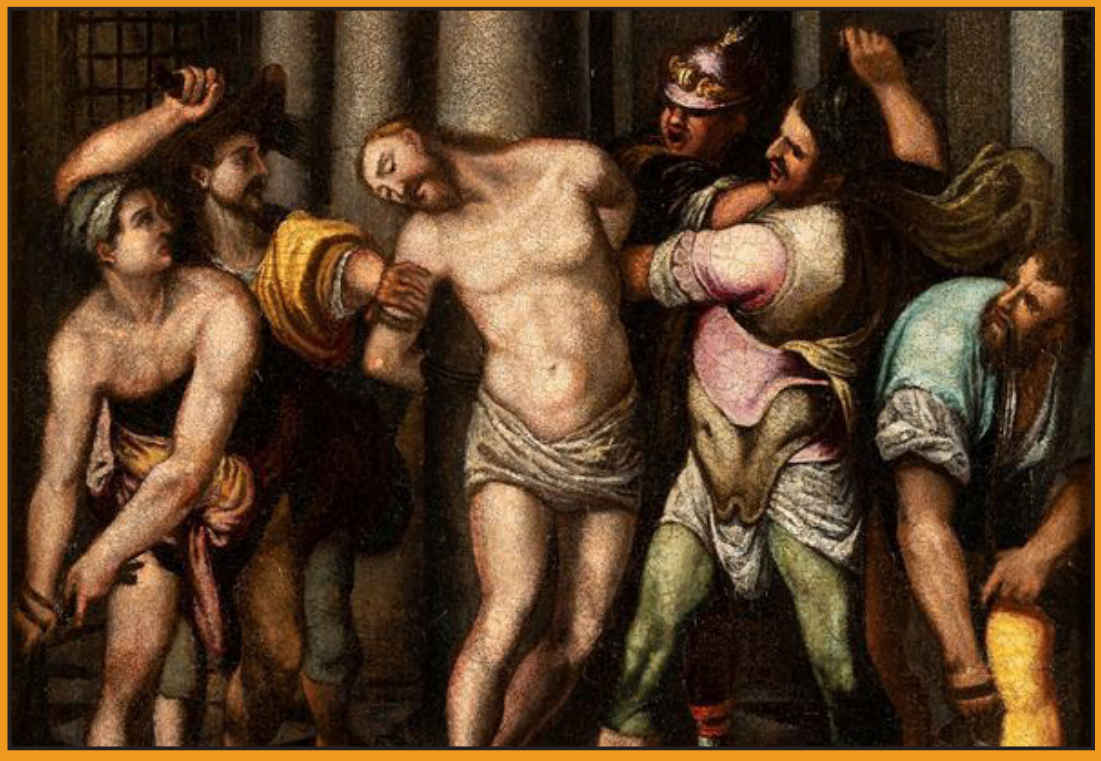
SUPPLEMENT



Taddeo Zuccari, *Flagellazione*, 1553 - 1556, Olio su tela, Chiesa di S. Maria della Consolazione,, Roma *(dettaii)*.

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Case report

TREATMENT OF AN ADULT PATIENT WITH UNILATERAL CLASS II DIVISION 2 MALOCCLUSION USING CLEAR ALIGNERS: A CASE REPORT

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ABSTRACT

Class II malocclusion is one of the common conditions encountered in orthodontic practice. While growing cases of Class II are candidates for functional or orthopedic appliances, adults are often treated with camouflage or surgery. With the growing demand for esthetic treatment options, this report aimed to describe an adult case of Class II Division 2 malocclusion with significant deep bite successfully managed with mesialization of mandibular dentition using clear aligners. This case report describes the treatment of an adult patient with unilateral class II division 2 malocclusion with a severe deep bite who presented with the chief complaint of whitening. The buccal segment relationship and deep overbite were treated using clear aligners through the protocol of lower molar mesialization, extrusion of posterior teeth, proclination and intrusion of anterior teeth. With 83 aligners, the aesthetic profile correction of deep bite and molar relationship was improved in twenty months, followed by cosmetic restoration of the maxillary anterior teeth to enhance smile esthetics. The results of this case demonstrated that clear aligners can be an important alternative for managing adult Class II cases requiring mandibular molar mesialization.

KEYWORDS: *adult orthodontics, class II division 2, clear aligners, deep bite*

INTRODUCTION

Angle's Class II Division 2 malocclusion is characterized by the distal position of the mandibular dentition, retroclined

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maxillary incisors, deep bite, and increased curve of spee with a backward path of closure (1). This malocclusion poses challenges to orthodontists owing to the complex nature of the problem due to overplay of genetic and environmental factors (1-3). Based on the growth status of the patient, the possible treatment options include functional or orthopedic appliances, camouflage with dental compensation, or orthodontics with orthognathic surgery. Extractions in class II div 2 cases pose a risk of deterioration of the facial profile, deep bite and incisor inclination. Orthodontic treatment in adults is further complicated with limited options, periodontal health, loss of alveolar bone, presence of restorations, increased bone density, and decreased cellularity and vascularity of the bone (4-6).

Over the last few years, orthodontic developments have been accompanied by a significant increase in the esthetic demands of patients (7). Introduced by Kesling and launched on the market in the late 1990s, nowadays clear aligner therapy (CAT) is a vital part of orthodontics, and their demand is growing at an increased pace among patients, especially adults, owing to their aesthetic properties and clinical efficacy (8, 9). Over recent years, many studies with clear aligners have shown their excellent efficacy in correcting crowding, distalization, expansion of narrow arches, significant rotation, closing/opening spaces, and even complex cases such as the resolution of deep bite, open-bite, and poor occlusal relationships(10-12).

This report aimed to describe an adult case of Class II Division 2 malocclusion with significant deep bite successfully managed with mesialization of mandibular dentition using clear aligners.

MATERIALS AND METHODS

Diagnosis and etiology

A 47-year-old male patient presented at the dental office with the chief complaint of "teeth whitening". Clinical examination revealed a concave profile due to a prominent bony chin, inadequate maxillary incisors exposure, non-consonant smile arch, thin but competent lips, and adequate vertical dimension of the face. Intra-oral examination showed the lower dental midline shifted to the right side by 1 mm compared to the upper dental midline. Besides, there was a unilateral class II molar and canine relationship on the right side, overbite of 4 mm, overjet of 0 mm and Bolton overall discrepancy of 93.29% (lower arch crowding index). The upper arch was narrow and squarish in shape with buccal tipping of the maxillary second and third molars, which were at a higher level than the occlusal plane, probably because they were not under the pressure of the orofacial muscles.

Table I. *Pre and post-treatment cephalometric values.*

Measurement	Norm	Pretreatment	Post-treatment	Change
Skeletal component				
SNA	**81°**	77°	78°	1°
SNB	**79°**	77°	78.5°	1.5°
ANB	**2°**	0°	-0.5°	-0.5°
Wits appraisal	**-2 to 2 mm**	1 mm	1 mm	0 mm
Gonial Angle	**130° ± 7°**	125°	126°	1°
Upper gonial angle	**52° to 55°**	54°	55°	1°
Lower gonial angle	**70° to 75°**	71°	71°	0°
NS-Ar-GoGn	**396°**	382°	390°	8°
SN-GoMe	**32°**	30°	31°	1°
Dentoalveolar component				
U1-SN	**102° ± 2°**	93°	106°	13°
IMPA	**90° ± 3°**	84°	94°	10°
Interincisal angle	**135°**	145°	129°	-16°

Aesthetic Arnett analysis revealed a flat profile due to maxillary and mandibular biretrusion, with an increased chin projection and retropositioned lips (Fig. 1). The nasolabial and mento-labial angles were increased. The hypertonia of the orbicular oris muscle was noted, probably resulting in retroclination of upper and lower incisors, with a deep curve of Spee in the lower arch (Fig. 2a-2b).

The cephalometric analysis (Fig. 3) showed skeletal class I relationship (ANB = 0°, Wits appraisal = 1 mm), retrognathic maxilla and mandible (SNA = 77°, SNB = 77°), retroclined maxillary and mandibular incisors (IMPA = 84°, U1-SN = 93°), and tendency towards brachyfacial pattern (Sn-GoMe = 31°) (Table I).

The presence of deep bite along with retroclined incisors has led to trauma from the occlusion and inflammation of the periodontium around the incisors. In addition to this, abfractions and incisor enamel abrasions were also present. Panoramic radiography revealed full dentition, absence of infections and no temporomandibular joint abnormalities (Fig. 3).

Fig. 1. *Pre-treatment extraoral photographs, smile detail and overjet photograph.*

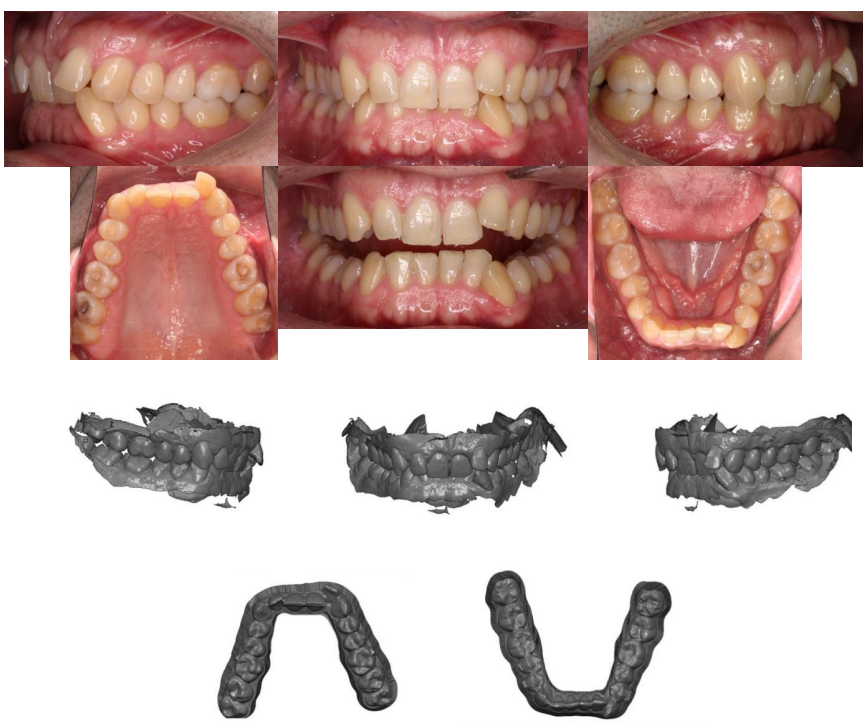

Fig. 2. ***A)*** *Pre-treatment intraoral photographs;* ***B)*** *Pre-treatment dental cast.*

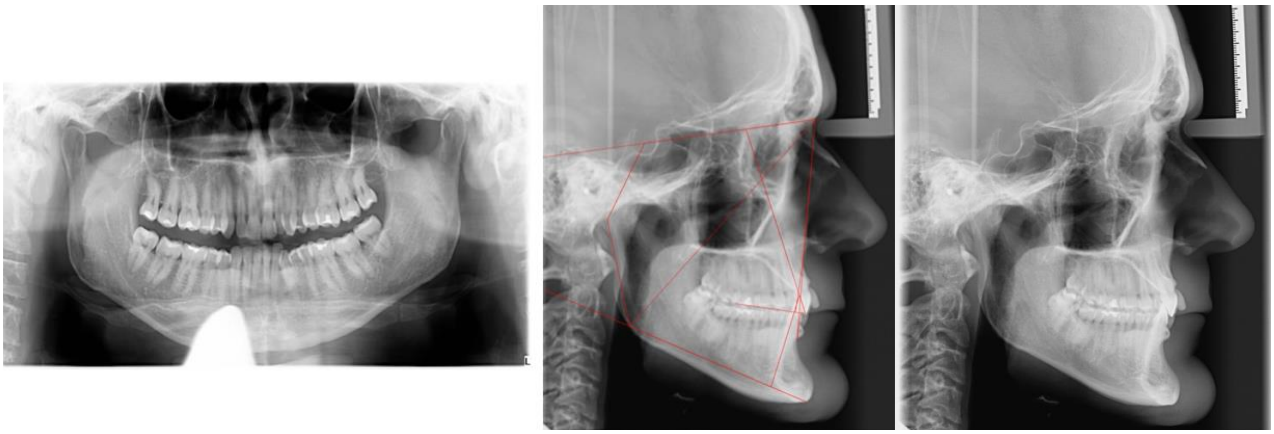

Fig. 3. *Pre-treatment panoramic radiograph and cephalometric tracing.*

The only treatment option suggested was an orthodontic treatment approach with clear aligners and resin minimal invasive direct restorations.

Treatment objectives

The treatment planning is focused on fully rehabilitating the patient to prevent future periodontal damage. The main objectives were:

To obtain interocclusal harmony by achieving class I molar and canine relationship

To correct a deep bite, providing proper canine and incisal guidance during the protrusive and lateral excursion.

Improve facial aesthetics by obtaining optimum upper and lower incisor inclination for adequate lip support at rest.

To preserve the current vertical dimension of occlusion.

Treatment progress

The digital treatment plan provided 83 Spark aligners (manufactured by Ormco, advanced clear aligner technology with TruGen™ materials) in the upper and lower arch for twenty months of treatment. In order to have a predictable clinical outcome for a deep bite and class II correction, we used 3D controls in the virtual simulator (Spark Approver). In the upper arch, the plan involved three kinds of simultaneous reciprocal movements:

First reciprocal movement = Action: constriction, disto-palatal-rotation, relative extrusion by palatal-crown torque of second molars until obtaining an oval arch form. Controlled sagittal reaction: simultaneously controlled proclination and intrusion of incisors, a predictable movement previously planned on Approver software.

Second reciprocal movement = Action: constriction of second molars. Controlled transversal reaction: expansion, mesial-buccal-rotation, and buccal root torque of first molars and premolars. (The buccal root torque is compensation to go against the resistance of the alveolar bone and to avoid the non-desired buccal inclination of the crowns during the expansion that can result in posterior open bite).

Third reciprocal movement = Action: second molars relative extrusion during constrictions. Controlled vertical reaction: relative incisors intrusion for levelling the curve of Spee.

For the management of the lower arch, the main objective was to unlock the anterior overbite and flatten the curve of Spee (from the first premolar to the first premolar). The sequence of movement planned includes:

Constriction, disto-lingual rotation and lingual root torque of seconds molars simultaneously with the proclination and intrusion of incisors and canines.

When the incisors were inclined at 92° to the mandibular plane and the canines were in the correct position, unilateral sequenced mesialization of posterior teeth on the right side was begun. The sequence started by mesializing the first and second premolars. When the first premolar achieved its final and correct position, mesialization of the first molar was

programmed. When the second premolar also achieved the final and correct position, the second molar was mesialized. Consequently, spaces are created mesially and distally of each tooth into which the plastic of the aligners is inserted to avoid the tendency of mesial crown tipping during mesialization. The mesialization was performed by moving two teeth simultaneously to avoid anchorage loss. The total mesialization was 3.4 mm.

Proclination and intrusion of lower incisors and lower canines simultaneously to constriction, distal-lingual-rotation and lingual root torque of second molars were prescribed to create an oval arch form.

The lingual root torque of lower second molars was compensatory to avoid increasing the curve of Wilson, which could increase by non-desired lingual crown torque. Due to the patient's periodontal condition, the centre of resistance of the teeth was at a lower point; thus, to have predictable movement, the length of the aligners was over-extended on the buccal surface to apply the forces closer to the centre of resistance. With the coverage of the whole teeth surface (buccal, lingual, occlusal, mesial and distal) during unilateral lower mesialization, we avoided the mesial tipping that usually happens using traditional multibrackets biomechanics with round wires.

The second and third molars were utilized to increase anchorage, which was the key to obtaining simultaneous and reciprocal movements in the upper and lower arches. After the orthodontic phase, extractions of the lower third molars were planned. The patient was instructed to wear each aligner for 22 h per day and to move on to the next one in the series after seven days (13, 14). After achieving a stable and coordinated occlusion, non-invasive direct restoration using composite resins on anterior teeth 11, 12, 13, 14, 21, 22, 23, and 24 was performed, with no dental preparation. The purpose of this restoration was both aesthetic and functional in resolving Bolton's discrepancy and providing adequate proportions of teeth to get symmetric canine and protrusive guidance.

RESULTS

After 20 months of active treatment with aligners, satisfactory results were obtained with the fulfilment of all the preset objectives. The buccal corridors were minimized with a balanced smile arch, and an ideal relationship between upper incisors and lower lip was noticed (Fig. 4). Aesthetic Arnett analysis revealed an improvement in aesthetic profile with correct lip position and reduction of nasolabial and mentolabial angles that could be appreciated through the optimal inclination of upper and lower incisors.

Fig. 4. *Post-treatment extraoral and photographs.*

Intraoral examination (Fig. 5a, b) revealed Class I molar, canine and incisor relationship, with a 3.4 mm of lower right molar mesialization, 5 mm of lower incisors intrusion, 3 mm of upper incisors intrusion, 7 mm of upper incisors proclination and 9 mm of lower incisors proclination. The vertical dimension was preserved because only the upper second molars were extruded till they reached the occlusal plane. The crowding was resolved, and the upper and lower dental midlines coincided with the facial midline. A reliable superimposition between real clinical conditions and digital set-up position was reached without digital overcorrection. Cephalometric results (Table I) and post-treatment lateral cephalogram (Fig. 6) showed good vertical control and optimum inclination of the lower and upper incisors.

Post-treatment panoramic radiography (Fig. 7) showed good root parallelism, no crestal bone height reduction and no evidence of apical root resorption. CBCT (Fig.8a,b) shows good vertical control and proclination of the lower and upper

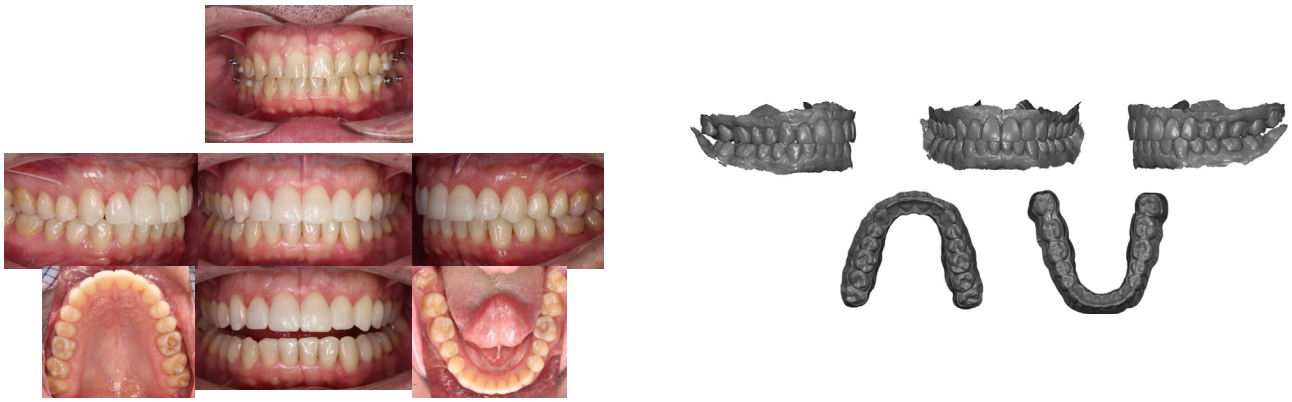

Fig. 5. ***A)*** *Post-orthodontics treatment and post-prosthetic rehabilitation intraoral photographs;* ***B)*** *Post-treatment dental cast.*

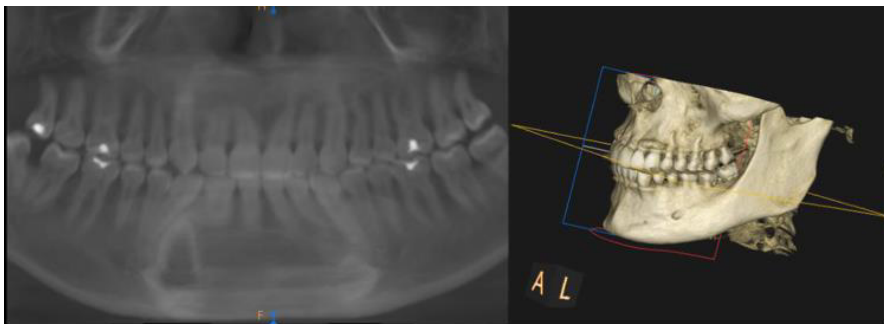

Fig. 6. *Final orthopantomography and 3D reconstruction.*

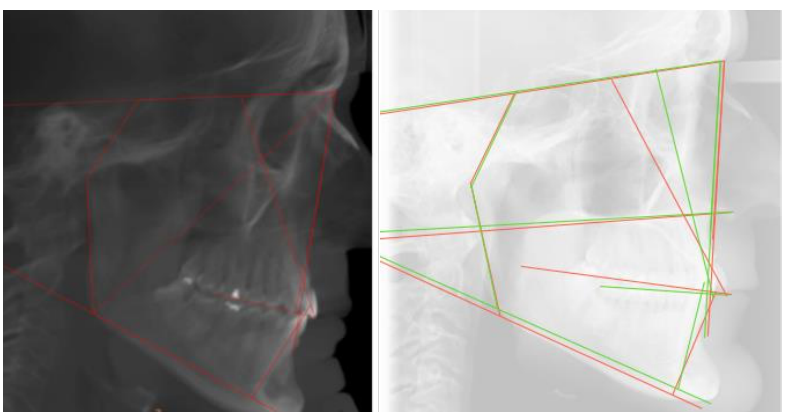

Fig. 7. *Post-treatment cephalometric tracing and superimpositions.*

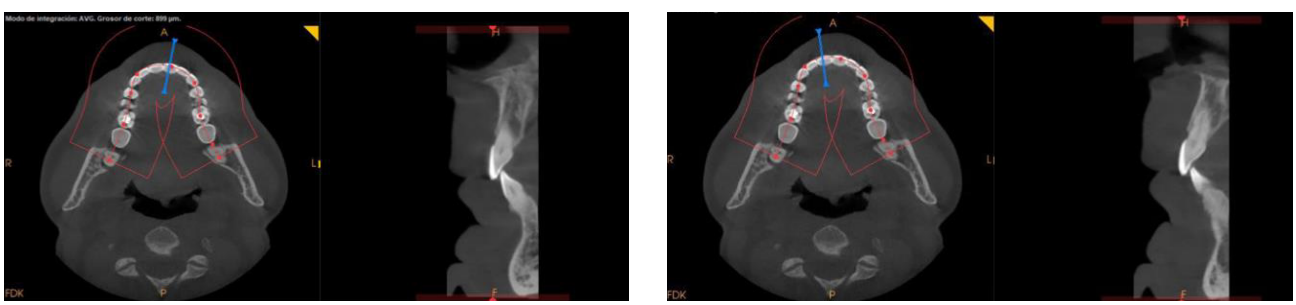

Fig. 8. ***A)*** *Sagittal section at the upper left central incisor, post treatment.* ***B)*** *Sagittal section at the upper right central incisor, post treatment.*

incisors. Patients were instructed to wear removable retention appliances during the night. After 24 months from the end of the treatment, the result is stable and optimal occlusion is maintained (Fig. 9).

DISCUSSION

The patient showed classical features of class II division 2 malocclusion with retroclination of incisors and deep bite. Class II Division 2 cases often present with increased resting lip pressure leading to retroclination of incisors, and the case presented also showed similar features (15-18). Besides, there was the presence of a severe deep bite with a potential for traumatic injury to the maxillary palatal gingiva. After treatment of 20 months with aligners, the incisor inclination was corrected, and the interincisal angle increased along with deep overbite correction (19-21). Maintenance of proper interincisal angle plays an important role in the stability after deep bite correction (14, 21-23).

The lower incisors inclination was maintained at 94°**,** suggestive of a nearly upright position over the mandibular basal bone. This upright position further adds to the retention and stability of the treatment results.

Treatment in adults poses a different challenge than in children and adolescents owing to differences in biomechanics, tissue reaction, periodontal conditions, acceptability of treatment options, and the adaptability of the soft and hard tissues. The resorption of alveolar bone leads to a decrease in the root surface area in contact with the bone, suggesting the need for light force in adults. Besides, shifting the centre of the resistance to a more apical position creates a larger moment of the forces. Clear aligners provide intermittent forces that limit the movement for each tooth to 0.25 mm every week, instead of the continuous one provided by fixed multibracket appliances, which vary from 0.15 to 1.24 mm every week (24). It is essential to apply proper forces to preserve the periodontal ligament and produce an effective tooth movement (25).

Extraction of four premolars (26) and inter-proximal reduction (27) to resolve Bolton discrepancy have not been considered because of the risk of worsening the profile. Distalization of the upper arch and retraction of anterior teeth is an efficient treatment alternative (28-29) for class II treatment, but this option was not selected due to the retrusive jaws. Class II elastics with the fixed orthodontic appliance is the most widely used treatment approach in Class II but is

Fig. 9. *Follow-up 24 months after the end of the treatment.*

associated with unwanted effects, including extrusion, retrusion and uncontrolled lingual inclination of maxillary incisors, buccal inclination and intrusion of lower incisors, extrusion and mesialization of mandibular molars and clock-wise rotation of the occlusal plane (30, 31). Clear aligners with class II elastics provide a viable option that provides adequate control of extrusion and inclination of upper incisors; however, in the presented case, the amount of mesialization was important to achieve a class I molar and canine relationship.

In managing deep bite, the intrusion of the mandibular incisors should be combined with the extrusion of the posterior segment (14). In this case, due to clear aligners biomechanics and bite effect, it has been possible to treat the augmented curve of Spee, keeping the initial vertical dimension through the intrusion of upper and lower incisors (32) simultaneous to proclination, avoiding the extrusion of posterior segments. Only the maxillary second molars were extruded by palatal crown torque till the crown reached the occlusal plane. The commonly named "bite effect" is a great advantage of clear aligners, which prevents molar extrusion, offering better control of the stability of the occlusal plane (33).

Finally, interdisciplinary management can give the best possible esthetic and functional outcome in managing cases with multiple problems. (34). In this case, minimally invasive restorative procedures and orthodontic treatment improved function and facial/dental aesthetics.

CONCLUSIONS

Mesialization of lower molars with clear aligners was a reliable and efficient option in managing Class II Division 2 cases, providing better aesthetic and functional results. With clear aligners, second molars are considered the key to doing simultaneous and reciprocal movements in the arch, avoiding anchorage loss. The intrusion of incisors without the extrusion of molars for levelling the curve of Spee was crucial to maintaining the vertical dimension.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Consent for publication

A written consent for publication was obtained from the patient.

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Technical Note

SPARK™ CLEAR ALIGNERS SPACE OPENING ORTHODONTIC TREATMENT IN A TEEN PATIENT WITH SEVERE DENTAL CROWDING, IMPACTED UPPER CANINES AND COMPLETE TRAUMATIC OVERBITE: A CASE REPORT

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ABSTRACT

This article describes the complex case of a teen patient with severe dental crowding, impacted upper canines, complete traumatic overbite and bimaxillary retrusion and his orthodontic treatment with Spark™ clear aligners. To achieve an optimal result, accurate planning in the *Approver*™ was necessary, following the principles of *face-driven* orthodontics. The patient, motivated by the high aesthetic performance of the chosen appliance, provided optimal compliance, essential for achieving all the planned treatment objectives. After only 12 months of orthodontic treatment, the patient and his

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parents were satisfied with the results, reflecting what had been planned initially. It can therefore be said that Spark™ clear aligners represent a reliable and efficient appliance which is suitable for all types of complex orthodontic treatments, even the most complex ones, in addition to being comfortable and almost invisible.

KEYWORDS: *Clear Aligners, Dental Crowding, Deepbite, Class II*

INTRODUCTION

In teen patients with severe crowding, a commonly observed dental issue is the lack of space for permanent teeth to erupt properly, resulting in impacted teeth, and crooked or rotated teeth (1, 2). This type of malocclusion can be challenging to treat due to the severity of the crowding, which may be caused by a combination of genetic and environmental factors, including the size of teeth, jaws, and soft tissue structures, as well as habits like thumb-sucking or tongue-thrusting.

Furthermore, if permanent teeth erupt rotated or remain impacted, other complications may be observed, such as tooth decay, gum disease, or temporomandibular disorder (TMD) (2, 3).

Usually, orthodontic treatment options for this malocclusion in adolescents may include braces, clear aligners, or a combination of both (4, 5). Clear aligner therapy has gained popularity in recent years, particularly among adolescent and adult patients, due to its discreet appearance and removable design (6-9).

The treatment plan is typically designed using digital models of the patient's teeth, which allow for precise control of tooth movements, and it can be modified as needed throughout the therapy (10).

Clear aligners can be removed for eating and oral hygiene manoeuvres, so they represent a convenient option for patients who are concerned about the impact of the orthodontic treatment on their daily activities (11-13). Orthodontic treatment in adolescent patients with severe crowding can also be complicated by other factors, such as limited space for the teeth to move, periodontal health, and the presence of restorations (14).

Fig. 1. *Intraoral and extraoral photographs before the orthodontic treatment*

However, with proper planning and management, these challenges can be overcome, and a successful outcome can be achieved. To develop a treatment plan that addresses their unique needs and concerns, the orthodontist must closely interact with the patients and their families, while evaluating the risks and benefits of different treatment options (15). Regular monitoring and adjustments throughout the course of treatment will help ensure that the patient achieves the desired results, which can lead to an improvement in oral health and overall well-being.

This case report describes the successful management of a teen patient with severe crowding using clear aligners which provided an aesthetically pleasing and effective treatment option for the patient's complex malocclusion, avoiding the need to perform extractions to solve the Bolton discrepancy, resulting in straighter teeth and an improved occlusion that will benefit their oral health and overall quality of life.

DIAGNOSIS AND ETIOLOGY

A 12-year-old healthy male patient came to our Dental Office for an orthodontic evaluation. He had undergone a previous, interceptive orthodontic treatment by another dentist and had therefore been wearing a transpalatal arch for the last 6 years (Fig. 1). The extraoral examination showed a skeletal class II and a normodivergent facial pattern. The profile was convex and biretruded, cheekbones were well represented, and lips appeared competent (Fig. 1).

The upper dental midline was centered on the facial midline, while the lower one was slightly deviated to the right. The patient's smile was narrow, with the presence of dark buccal corridors, whilst the gingival exposure adequate for the patient's age. Moreover, the intraoral examination showed:

Severe crowding in both arches, due to dento-basal discrepancy, with no space for permanent upper canines and ectopia of the lower ones;

A class II subdivision malocclusion, with molar class I on the left side, molar class II on the right side and a non-assessable canine class, due to the failure of element 1.3 and 2.3 to erupt;

An Angle class II division II malocclusion, with a slightly reduced Overjet and a complete Overbite, with an increased lower static curve of occlusion, over erupted lower incisors and trauma of the retroincisive papilla;

Uncoordinated dental arches;

Non-coincident dental midlines.

The cephalometric analysis confirmed the traits described in the extraoral examination (skeletal class II with biretrusion, normodivergent facial pattern, retrusion of upper incisors in relation to the anterior nasal spine and of lower incisors relative to the pogonion) (Fig. 2).

The main concerns of the patient and his parents were the lack of space for the eruption of the upper canines, the severe crowding and misalignment in the lower arch and the traumatism of lower incisors on the palatal mucosa.

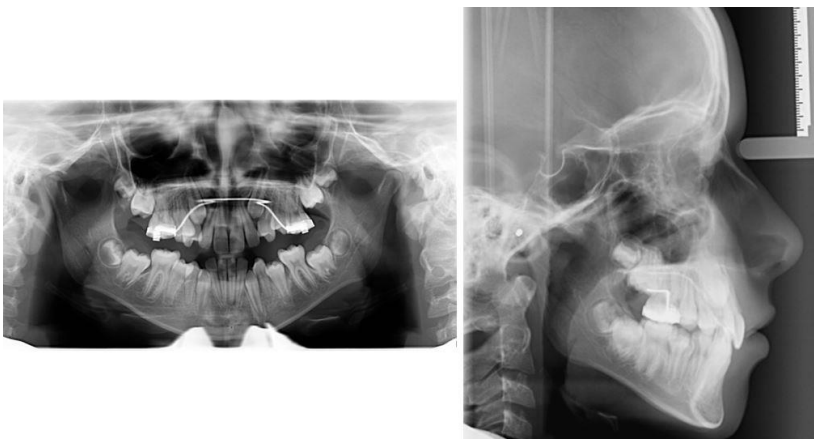

Fig. 2. *Orthopantomography and Cephalometry before the orthodontic treatment*

TREATMENT ALTERNATIVES

The concomitant presence of severe dental crowding and increased static curve of occlusion (the upper one was also slightly deepened) required a great amount of space to resolve the malocclusion.

This space could be obtained by extracting one premolar in each hemiarch, but that would not have improved the patient's biretruded profile and could even worsen it.

A combined orthodontic-surgical treatment (bimaxillary advancement after the extraction of four premolars to resolve the crowding) was not indicated for the patient, considered his age, his chief complaint (he was worried about the severe crowding but was not bothered by his biretruded profile) and the absence of relevant asymmetries or disharmonies of the face.

Therefore, considered the harmonic and normodivergent facial pattern of the patient and the retrusion of both upper and lower incisors, the treatment of choice was a non-extraction orthodontic treatment with Spark™ clear aligners, in which the opening of spaces for permanent upper canines eruption was achieved via expansion, anterior proclination and distalization in the upper arch.

TREATMENT OBJECTIVES

The Approver™ (Fig. 3) was planned according to the principles of *face-driven orthodontics*, to improve smile

and profile aesthetics, and the patient's occlusion was evaluated both statically and dinamically.

The so-elaborated treatment had the following objectives:

Resolve the crowding, obtaining the necessary space to allow the correct eruption of upper and lower permanent canines;

Reach complete and bilateral molar and canine class I;

Correct the deep bite, flattening the static curve of occlusion;

Reduce incisor retrusion, improving lip support;

Center the mandible and, therefore, the lower dental midline;

Coordinate the shape of dental arches;

TREATMENT PROGRESS

The first digital treatment plan provided 28 Spark aligners (manufactured by Ormco, advanced clear aligner technology with TruGen™ materials) changed every 7 days and worn until the 28th with perfect fitting. This phase lasted 7 months.

The finishing digital treatment plan provided 18 Spark aligners changed every 7 days, in order to: guide and finalize the extrusion of upper canines and correct their torque; complete the flattening of the lower static curve of occlusion by intruding the lower incisors; improve posterior contacts by extruding upper and lower second molars. This phase lasted 4'5 months (Fig. 4-5).

As for retention, the patient was given upper and lower Spark passive aligners made with Trugen XR material for extra rigidity, without attachments, to be worn for 6-8 hours a day, usually at night.

Space opening was planned as a combination between two reciprocal sagittal movements: on the one hand the distalization of molars and on the other hand the proclination of incisors. This allowed us to gain more than 20mm of space in both arches without the need for class elastics or skeletal anchorage.

More precisely, the following movements were planned to ensure maximum predictability of the outcome:

Upper first molars and premolars were distalized to create space for the canines, at the same time, both upper and lower incisors were proclined and intruded.

Lower incisors were intruded 4 mm and upper incisors were intruded 3 mm, this resulted in flattening the static curve of the occlusion.

Eruption compensators were not added to the upper aligner until 2/3 of the space needed for the eruption of canines

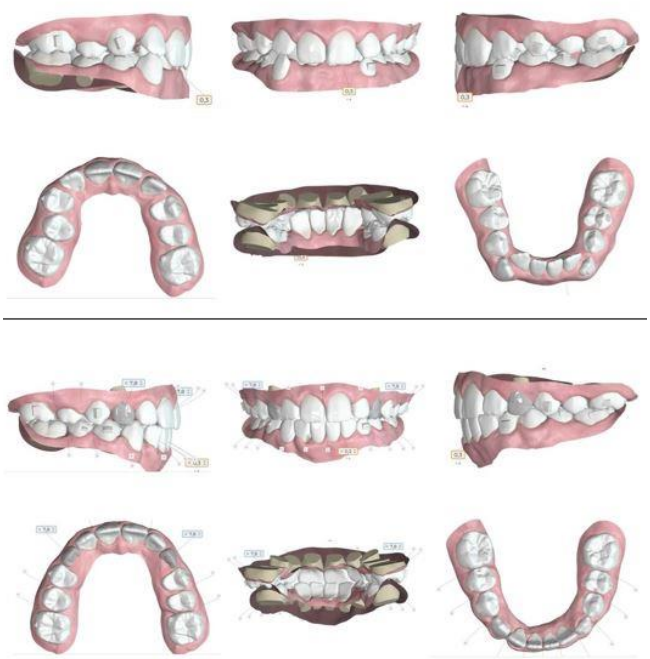

Fig. 3. *Initial Approver® planned by the clinicians, for the first phase of the treatment*

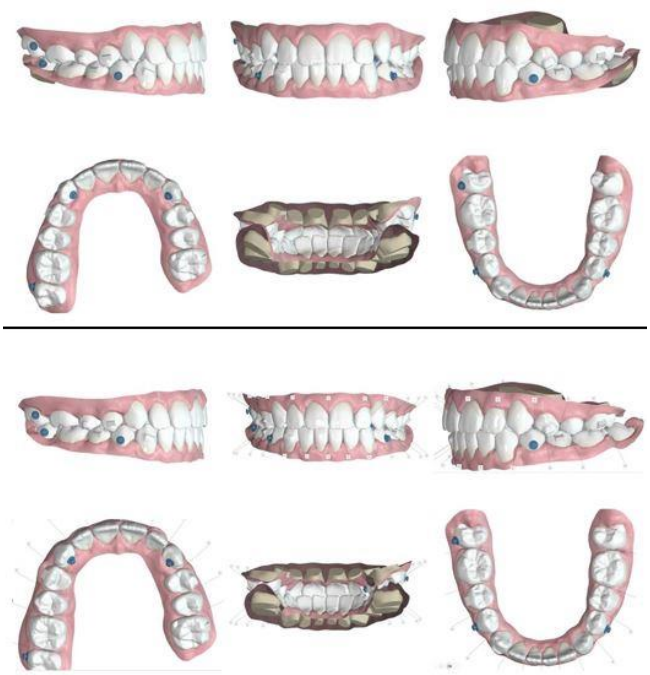

Fig. 4. *Approver® planned by the clinicians for the first set of additional aligners*

was obtained, this have been done to prevent adjacent teeth from mesial or distal tipping.

During the last part of the first treatment phase, in which the upper canines were erupting, intraoral elastics has been used and those had the following direction (Fig. 6):

From the buccal side of the upper canine to the buccal side of the lower first premolar, to guide the eruption of upper canines into the eruption compensators.

When the canine was completely erupted, a new scan of the dental arches was taken and the second phase of the treatment started. During this phase, the design of the elastics was changed as following (Fig. 6-7):

From the palatal side of the upper canines to the buccal side of the lower first premolars, on both sides, to extrude the canines and improve their torque.

From the buccal side of the upper and lower right second molars, to extrude elements improving occlusal contacts, to ensure the maintenance of strong occlusal contacts and to prevent the development of a posterior open bite.

The patient used vertical elastics 1/8 diameter / 4´5oz, during whole treatment, only night use (6-8 hours a day), worn on aesthetic buttons.

Fig. 5. *Intraoral photographs at the end of the first set of additional aligners (aligner 46)*

Fig. 6. *Intraoral photographs at the end of the first set of aligners (aligner 28), showing the design of vertical elastics*

Fig. 7. *Intraoral photographs showing the fitting of additional aligners and the design of elastics during the second phase of treatment*

RESULTS

After only one year of orthodontic treatment, all set goals were reached, with complete resolution of dental crowding and the achievement of a correct occlusion. Extraoral final photographs showed a wider smile, with no buccal corridors, and a more harmonious and less retruded profile, with better lip support. The gingival exposure at the smile, which was adequate at the beginning of the treatment, was maintained as such (Fig. 8).

As can be seen from the intraoral post-treatment photos, dental crowding was resolved completely, with an ideal dental alignment and coordinated shapes of dental arches, and a perfect molar and canine Angle class I occlusion was reached (Fig. 8).

The comparison of cephalometric values (Fig. 9, Table I) and the superimposition of cephalometric tracings (Fig. 10) before and after the orthodontic treatment, underline the success of our therapy and show the improvement in incisor positioning and lip support.

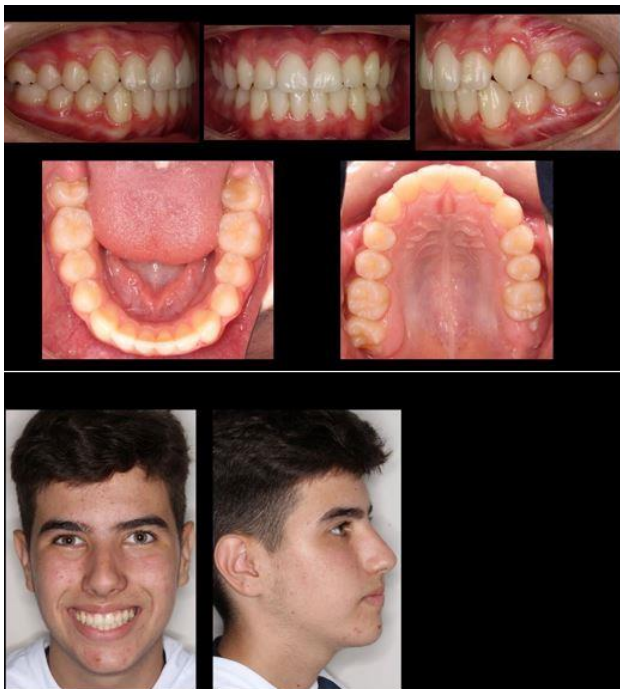

Fig. 8. *Intraoral and extraoral photographs at the end of the orthodontic treatment*

Furthermore, a final CBCT demonstrates how the roots of all teeth have been kept within the alveolar bone and therefore inside the periodontal envelope. These treatment results truly satisfied the patient and his parents and fulfilled their chief complaints. Moreover, they really appreciated comfort and low aesthetic impact of the chosen appliance, as well as the simpler management of daily oral hygiene. The stability of the treatment after one year was excellent as show in photo 1.

DISCUSSION

The main criticalities of this orthodontic treatment are listed and briefly discussed below. The choice to open the space for the canines surely complicates the treatment, especially in the upper arch where spaces were almost completely closed but was more coherent with the principles of MID (Minimally Invasive Dentistry) and *face-driven orthodontics*, considered the retrusion of the lips and the incisors and the presence of buccal corridors.

The opening of wide spaces, as has been done in this patient, is a complex movement to be achieved with aligners, as it requires the repositioning of the entire dental elements, including the roots (bodily movement), and not only the movement of crowns (uncontrolled tipping) (8, 16).

In this case, the space was obtained partly by distalization of upper molars and premolars teeth and partly by proclination of incisors: these two movements were planned at the same time, since they are reciprocal

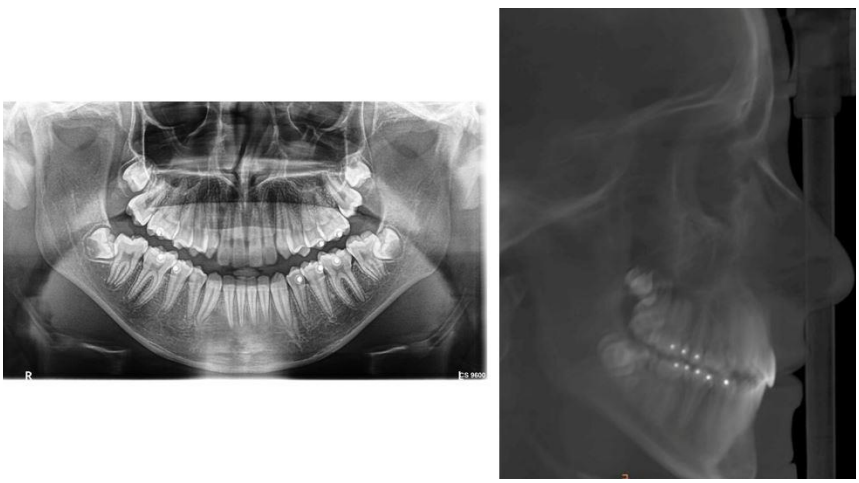

Fig. 9. *Orthopantomography and Cephalometry at the end of the orthodontic treatment*

movements, which means that they represent each other's natural reaction (8, 17). That is also the reason why the patient did not have to wear sagittal elastics as anchorage for the distalization and it allowed us to distalize in without worrying about anchorage loss.

Indeed, during these two reciprocal movements, aligners are always using a push force and becoming progressively longer, thus avoiding the problem often associated with distalization, which consists in maintaining posterior anchorage during anterior retraction (the aligner shortens progressively, after the distalization) (18).

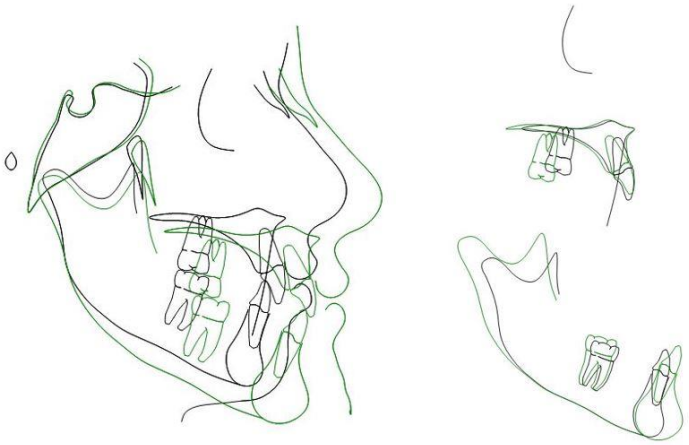

Fig. 10. *Superimposition of initial and final cephalometric analysis*

In order to properly control the mesio-distal tipping of the first premolar and the lateral incisor in the upper arch, it is essential not to add the eruption compensator to the aligner until 2/3 of the space required for the canine has been obtained: in this way, a bar will be inserted into the space, which will allow the aligner to apply the pushing force closer to the teeth center of resistance on the distal surface of the lateral incisors and on the mesial surface of the first premolars.

On the other hand, in the lower arch, where canines are already erupted, though misaligned and not levelled, the very presence of the crowns of the canines allows a better control of the tipping of lateral incisors and first premolars.

Since the dental arches have been expanded significantly and the incisors, both upper and lower, have been proclined considerably, it was crucial for the patient to have periodontal tissues in excellent health before the treatment and to maintain them throughout the entire therapy. Therefore, the fact that, with removable orthodontic appliances such as aligners, maintaining optimal home oral hygiene is easier than with fixed appliances is certainly an advantage (11-13).

As for elastics, the patient wore them only during the night hours. Additionally, the use of elastics was very helpful in maintaining strong occlusal contacts, but since they were not needed as anchorage, the patient never had to wear them all day. This made it possible to obtain excellent collaboration from the patient.

Furthermore, elastics were worn only on direct buttons: this way, the force of elastics is transferred directly to the teeth involved, without affecting the fitting of the aligner (9, 19, 20). A valid alternative to direct buttons could have been integrated hooks (which are a combination between a hook, for wearing the elastic, and an attachment, to ensure perfect fitting), but at the time this treatment was performed they had not yet been implemented in the Spark™ system. Metal buttons were bonded on posterior elements and the palatal surface of upper canines, while aesthetic buttons, made of composite resin, were applied on the buccal surface of the upper canines and the first premolars of the right side. Summing up, biomechanics with aligners works thanks to 3 fundamental aspects (8):

The plastic material (TruGEN™) of which aligners are made and the amount of material that surrounds the teeth;

The reciprocal movements, planned simultaneously;

The features (attachments, bars, eruption compensators, button cut-outs, etc.);

CONCLUSION

All dental movements planned in the Approver™ (Fig. 3-4) have been obtained almost perfectly, with excellent predictability; therefore, it can be said that the use of Spark™ aligners, if the orthodontic therapy is properly planned and managed, is an effective and reliable method for all types of cases, even the most complex ones.

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Technical Note

MANAGEMENT OF CLASS II DIVISION I MALOCCLUSIONS USING UPPER MOLAR DISTALIZATION IN ADULT PATIENT: A CASE REPORT

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ABSTRACT

This case report presents the management of class II malocclusion maxillary origin in a 45-year-old periodontal patient using upper molar distalization technique. Pre- and post-treatment records are provided. Aesthetic Arnett analysis revealed a convex profile due to maxillary projection, a protruding upper lip, and a good mandibular position. After 9 months of treatment, treatment goals were met, and the patient was pleased with the functional and aesthetic outcomes. Movement was more predictable when staged in distalization and molar tipping was avoided. Using aligners in conjunction with appropriate attachment location and geometry is an effective way of managing class II malocclusions, comparable to other methods while providing excellent aesthetics, oral hygiene, and quality of life.

INTRODUCTION

Class II malocclusion represents as one of the most common orthodontic problems. Malocclusion is defined as a distal relationship of the mandible to the maxilla with a combination that includes various dental and skeletal components that can negatively affect facial aesthetics and functional status. According to McNamara, the most common feature of Class II malocclusion has emerged as mandibular retrognathia rather than maxillary protrusion (1-3). The prevalence of Class

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II malocclusion varies depending on the population and the diagnostic criteria used. According to a 2018 systematic review, the global prevalence of Class II malocclusion was found to be higher in mixed dentition (23%) than in permanent dentition (19.56%) (4).

The treatment options for Class II malocclusion depend on the levels of severity of the condition, patient age, and other individual factors such as requiring orthodontic treatment to correct the malocclusion and improve oral health and function. The most commonly used treatment options for correcting Class II malocclusion of maxillary origin mainly include distalization and/or extraction and orthognathic surgery. In adult patients, upper molar distalization is considered one of the conservative ways to treat Class II malocclusion of maxillary origin. Biologically oriented preparation technique (BOPT) can be used in conjunction with orthodontics, as a finishing treatment. BOPT is a dental restoration technique that aims to preserve the natural tooth structure and surrounding tissues as much as possible while still providing a functional and aesthetically pleasing restoration. BOPT is a promising technique that can offer several benefits over traditional restoration methods, including better aesthetics, improved function, and increased longevity of the restoration.

However, it requires specialized training and expertise to perform effectively. This report aims to present a case with an effective staging protocol and attachment geometry planning with the clear aligner to correct a class II malocclusion maxillary origin in a periodontal patient.

Case presentation

A 45-year-old male patient came in for a routine check-up with the primary complaint of forwardly positioned upper front teeth. All specific patient information was de-identified. There was no relevant medical, family, or psychosocial history, nor was there any relevant genetic information. The patient had never had orthodontic treatment before.

Diagnosis

Extraoral examination revealed an oval face, facial symmetry, adequate maxillary incisor exposure, competent lips, and the lower third of the face was slightly increased. Aesthetic Arnett analysis revealed a convex profile due to maxillary projection, a protruding upper lip, a reduced nasolabial angle and a good chin position.

An intra-oral examination revealed that the lower dental midline was shifted 1 mm to the left of the upper dental midline, a bilateral class II molar and canine relationship, a 0.5 mm overbite, a 7 mm overjet, and upper and lower misalignment. The upper and lower arches were narrow, with a “V” shape (Fig. 1).

The cephalometric analysis (Fig. 2) showed skeletal class II relationship with an increased (ANB = 3,8°, Wit’s appraisal = 1,5 mm), prognathic maxilla and correct position of the mandible (SNA = 82,6°, SNB = 79°), proclined upper maxillary incisors and slightly retroclined the mandibular incisors (IMPA = 87°, U1-SN =115 °), and normal facial height (Sn-GoMe =36 °) as shown in Table I.

Angle classification for the patient was skeletal and dental class II division 1. Gingival recession, abfractions, and incisor enamel abrasions were also present in this periodontal patient.

Fig. 1. *Pre-treatment facial and intraoral photographs*

Table I. *Cephalometric analysis pre- and post-treatment*

Measurement	Pre-treatment	Post-treatment	Norm
Skeletal compenent			
SNA	82,6°	81,7°	**81°**
SNB	79°	79°	**79°**
ANB	3,8°	2,7°	**2°**
Wits appraisal	1,5 mm	1 mm	**-1 to 1 mm**
Gonial Angle	128°	**127°**	**130° ± 7°**
Upper gonial angle	49°	48°	**52°- 55°**
Lower gonial angle	79°	79°	**70° - 75°**
N-S-Ar-Go-Gn	396°	396°	**396°**
S-N/Go-Me	36°	37°	**32°**
Dentoalveolar compenent			
UI-SN	115°	103°	**102° ± 2°**
IMPA	87°	89°	**90° ± 3°**
Interincisal angle	120°	140°	**135°**
Overjet	6	3	**2,5**
Oberbite	0,6	1,7	**2,5**

The panoramic x-ray radiograph revealed complete dentition, no bone defects, no periapical lesions, no infections, and no temporomandibular joint abnormalities (Fig. 2). The only treatment option recommended was orthodontic treatment using clear aligners and resin minimally invasive direct restorations.

Treatment objectives and treatment plan

The digital treatment plan included 55 Spark clear aligners (manufactured by Ormco, advanced clear aligner technology with TruGenTM materials) in the upper and lower arch for 9 months of treatment and three appointments to gradually shift teeth into the desired position. We used 3D controls in the virtual simulator (Spark Approver) to achieve a predictable clinical outcome for class II correction. The primary treatment goals were to achieve class I canines and molars bilaterally using upper molar distalization orthodontic approaches. The objective of this treatment was to move the upper molars backward (distally) to correct the relationship between the upper and lower arch, resulting in a more harmonious occlusion. Additional objectives were to relieve the crowding in both arches, restore a pleasant smile with optimal lip line and smile arch and enhance the patient's profile. Distalization of the upper arch was chosen as a treatment option to improve the position of the upper lips relative to the chin and lower lip. Non-invasive direct restoration (BOPT technique) using composite resins on anterior teeth 11,12,13,21,22,23 was performed after achieving a stable and coordinated occlusion. All procedures were carried out in accordance with the ethical standards outlined in an appropriate version of the Helsinki Declaration.

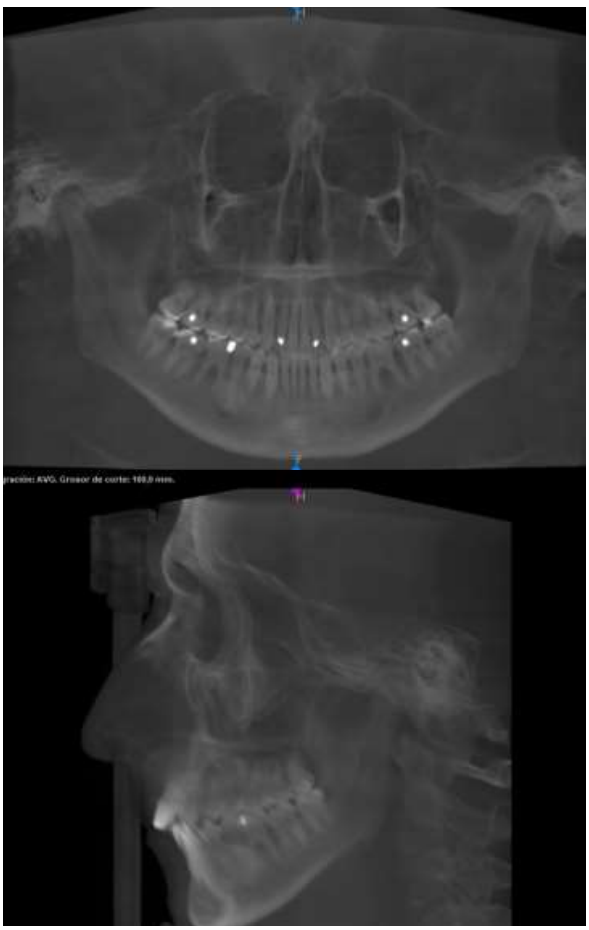

Fig. 2. *Pre-treatment lateral and panoramic radiographs*

Therapeutic intervention or treatment protocol

The digital setup (Approver) involved the use of computer software to create a virtual representation of the patient's teeth and jaws, allowing the orthodontist to plan the precise movements required to achieve the desired result.

On the upper arch, reciprocal movements represented by upper incisor proclinations during molar and premolar distalization were critical in preventing anterior anchorage loss. The treatment was completed without the extraction of the upper third molars.

Orthodontic set up of upper arch, distalization protocol

Sagittal plane: The second molars were distalized while the upper incisors were proclined. After 4 aligners, distalization of the upper first molars began, which involved a 1mm opening space useful for increasing the surface to be covered by aligners for tipping maintenance. Distalization of the second premolars began when the second molars reached their final and correct position. Anterior teeth retrusion from 13 to 23 was completed when the first molars achieved class I relationship and the second premolars reached their final position. Additional buccal root torque was prescribed to avoid proclination and achieve incisors bodily movement during restrusion.

Transversal plane: Compression for palatal-crown torque of the second molars as well as distopalatal rotation and relative extrusion. Similarly, the first molars were expanded by mesiobuccal rotation, followed by the addition of buccal root torque (to maintain the initial torque and avoid the tendency of over inclination and potential posterior openbite) until an oval arch shape was obtained. Premolar and canine teeth were also expanded.

Prescription of attachments

Only the first and second molars in the upper arch had HRGB (horizontal gingival bevel attachments). There were no additional attachments required to allow aligners to cover the entire buccal surface. By increasing the contact area of the aligners on the buccal surface until they cover the recessions, we could plan the application of forces closer to the center of resistance and improve predictability for molar expansion against alveolar bone resistance.

With the coverage of the whole teeth surface (buccal, lingual, occlusal, mesial and distal) during upper molar distalization, we avoided the mesial tipping that usually happens using traditional multibrackets biomechanics with round wires.

Orthodontic set up of lower arch

Transversal plane: Compression for lingual root torque (to avoid increasing the Wilson curve) and distolingual rotation of second molars (to achieve an oval arch) were planned simultaneously with expansion (mesial - vestibular - rotation) of first molars, premolars, and canine to correct inferior arch crowding and for arch alignment.

Vertical plane: Intrusion and controlled proclination between 33 and 43.

Prescription of attachments

HRGB (Horizontal Gingival Bevel Attachment) was placed on the lower first and second premolars.

Fig. 3. *Post treatment facial and intraoral photographs*

RESULTS

At nine months of treatment all of the predetermined objectives had been met, yielding satisfactory results. Aesthetic Arnett analysis revealed an improvement in the aesthetic profile: a reduced upper lip projection and a more opened nasolabial angle.

Lower dental midlines coincided with facial midlines. Intraoral examination revealed Class I molars and canines with upper molar distalization of 3 mm (Fig. 3).

Post-treatment panoramic radiography revealed good root parallelism, no crestal bone height reduction, and no evidence of apical root resorption. Without digital overcorrection, a reliable superimposition of real clinical conditions and the digital set-up position was achieved (Fig 4).

Table I shows cephalometric results that show a reduced SNA angle (from 82,6° to 81,7° and an ANB angle from 3,8° to 2,7°), good vertical control (S-N/Go-Me from 36° to 37°), correct incisor inclination (UI-SN from 115° to 103° and IMPA from 87° to 89°), and optimal overjet (from 6 mm to 3 mm) and overbite (from 0,6 mm to 1,7 mm). Follow-up at 3 years demonstrated the stability of results over time (Fig. 5).

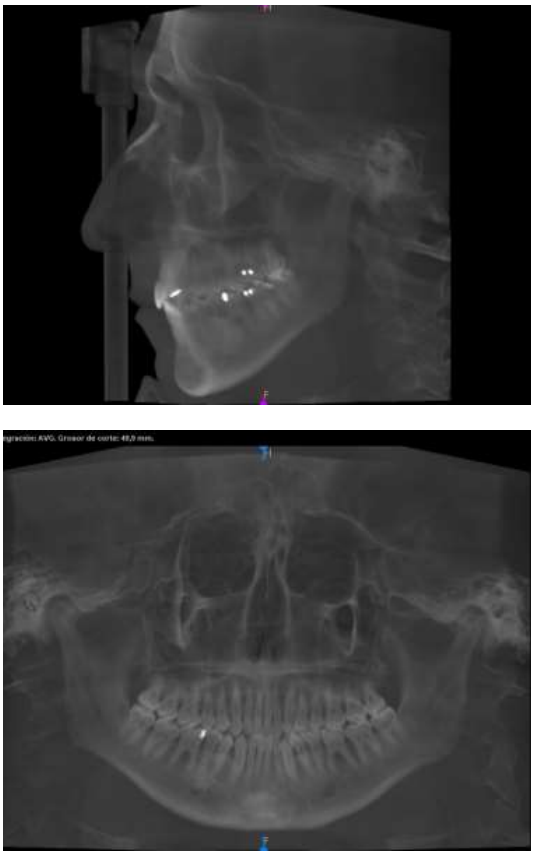

Fig. 4. *Post-treatment lateral, panoramic radiographs and superimposition*

Fig. 5. *Follow-up at 3 years*

DISCUSSION

The purpose of this case report was to explain how a dental and skeletal class II malocclusion of maxillary origin was managed using an effective staging protocol and attachment geometry planning with the clear aligner technique.

Different treatment modalities have been proposed in the literature to correct class II malocclusion, including the use of aligners, and some studies have used tooth extraction as well (5, 6). However, it is often associated with complex treatment with increased treatment time and additional expenses and requires more patient compliance throughout treatment. In the present case it would have been possible to perform a premolars extraction, but we were able to treat the patient even more conservatively through distalization protocol. Distalization of maxillary molars is frequently the treatment of choice in class II non-extraction patients (7). The distalization values achieved in this case were 3 mm for the second molar and 2,7 mm for the first molar, with no observed vertical or distal tipping movement, which were consistent with the mean reported distalization values in published literature (5, 8).

Two dimensions lateral cephalometric superimpositions were used to quantify the amount of tooth movements in this case, which was in accordance with standard treatment plan published in literature (5, 8).

Miniscrews or temporary anchorage devices were not used for upper molar distalization in the presented case because according to

our protocols, were not necessary to achieve the established objectives (9). In some cases, there may not be enough bone to support the miniscrew, or it may be difficult to find a suitable location for placement. Furthermore, using miniscrews can damage the roots of neighboring teeth (10-13).

In recent years, aligners have become increasingly popular as an alternative to traditional braces for orthodontic treatment, including molar distalization. One advantage of using aligners for molar distalization is that they are nearly invisible, making them a more aesthetically pleasing option compared to traditional braces (14, 15). Additionally, aligners are removable, making it easier to maintain good oral hygiene during treatment. Another advantage of using aligners for molar distalization is that they are custom-made to fit the patient's teeth, allowing for more precise movement of the molars. Distalization with aligners can be a great option to avoid tipping of the molars during orthodontic treatment (5, 8, 16).

Tipping occurs when a tooth leans in a certain direction due to the force applied to it during treatment. When molars are tipped too much, it can cause problems with the bite and potentially lead to other dental issues (12, 17).

The distalization movement caused by aligners in our case report was not associated with significant distal tipping of the distalized molars. Aligners were used to apply a controlled force to the molars to move them in a straight line, without causing them to tip. This was achieved through the use of precision attachments on the aligners, which are placed on the teeth to guide them into the correct position and because the coverage of the whole teeth surface (buccal, lingual, occlusal, mesial and distal) (5, 18, 19). Because each aligner has a self-limiting 0.25-mm activation for week, any tip created by the aligner during space closure is most likely due to insufficient moments being generated to control root movement, rather than the teeth "falling" or even being "pushed" into a pontic space (19). Overall, molar distalization with aligners can be an effective way to avoid tipping of the molars during orthodontic treatment.

In this case, upper molar distalization was preferred over surgery or tooth extraction. Upper molar distalization was found to be the most effective and comprehensive treatment approach based on patient protrusion of the upper lip due to maxillary prognatism. Distalization also produces more aesthetically pleasing results than tooth extraction which instead would have flattened the profile. The whole treatment objectives were accomplished for 9 months of treatment and included three appointments to achieve class I canines and molar bilaterally using upper molar distalization orthodontic approaches.

CONCLUSION

Upper molar distalization in adult patient can be performed with clear aligners and provides a reliable and efficient option in the treatment of class II malocclusion providing functional results, excellent aesthetic, oral hygiene and quality of life. Furthermore, it is crucial to use reciprocal movement of incisors proclination at the same time to molars distalization for achieve efficient movements without losing the anterior anchorage.

The use of aligners for molars distalization can be a great option to avoid tipping of the molars because the coverage of the whole teeth surface. Overall, aligners could be an effective option for molar distalization and can offer several advantages over traditional braces. The 3-year follow-up demonstrated the stability of results over time using this protocol.

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Case Report

TREATMENT OF SKELETAL ANTERIOR OPEN BITE WITH CLEAR ALIGNER AND TEMPORARY ANCHORAGE DEVICE IN AN ADULT: A CASE REPORT

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ABSTRACT

An anterior open bite causes esthetic and functional problems that can be addressed with careful identification of the etiology, nature, and severity of the underlying skeletal and dental discrepancies. Non-surgical orthodontic options include extrusion of anterior teeth or intrusion of posterior teeth or a combination of these two based on the patient's requirement. This case report describes a 45-year-old female who presented with the complaint of an unesthetic smile. She had skeletal anterior open bite and preferred a non-surgical esthetic option for the management of her malocclusion. The treatment started with Spark clear aligners along with TAD and after 15 months of treatment with 60 sets of aligners, combined with non-invasive direct restoration using biologically oriented preparation technique, we were able to achieve good esthetic and functional results.

KEYWORDS: *clear aligners appliance, openbite, orthodontic treatment*

INTRODUCTION

Open bite is defined as the lack of vertical overlap of the mandibular teeth by the maxillary teeth during maximum intercuspation which can be either in the anterior or posterior region (1). Dentoalveolar open bite is caused due to digit

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sucking habit that impedes the eruption of teeth and the development of alveolar bone. Skeletal openbite can be due to clockwise rotation of the mandible, anticlockwise rotation of the maxilla, any related skeletal deformation, or a combination of the above. Dentoalveloar openbite if detected at an earlier age is easier to treat whereas skeletal openbite in adults poses a great challenge to the clinician (2).

Adult patients with severe skeletal openbite benefit from a combination of orthodontics and orthognathic surgery whereas mild to moderate cases can be treated non-surgically with the intrusion of posterior teeth or extrusion of anterior teeth (3). Extrusion of the anterior teeth to close the bite is not often a good choice as incisors often show compensatory overeruption to the increased facial height. The intrusion of the posterior segment is often preferred as it leads to autorotation of the mandible and has a positive effect on the anterior facial height. The use of interarch elastics (Class II or III) is often discouraged in the skeletal open bite as it tends to extrude the posterior teeth (4).

The use of temporary anchorage devices (TADs) has broadened the boundaries of orthodontic treatment and overcome the traditional limitations of non-surgical orthodontic treatment. True molar intrusion has been made possible with TADs to achieve esthetic results in skeletal openbite. Clear aligner that has gained wide acceptance in adult orthodontic patients is found successful in open bite due to its occlusal coverage that can provide intrusive force (5, 6). The aim of this case report is to describe the management of a case with skeletal open bite treated with clear aligners and TADs.

CASE DESCRIPTION

Diagnosis and etiology

A 45-year-old female presented to the orthodontic clinic with a chief complaint of irregular front teeth and inability to completely close them. She did not have any significant past medical history or oral habits that could contribute to the etiology of anterior open bite. She had undergone restorations of a few teeth but had no experience with orthodontic treatment. Extraoral examination showed a nearly symmetrical face, convex facial profile, competent lips, and obtuse nasolabial angle (Fig. 1). There was no deviation, deflection, or other signs and symptoms of temporomandibular dysfunction.

Fig. 1. *Pre-treatment photographs.*

Intraoral examination revealed Class I molar and canine relationship with an anterior open bite of 2 mm. There was mild crowding of the anterior teeth in both the maxillary and mandibular arch. The upper dental midline coincided with the facial midline whereas the lower dental midline deviated to the left by 1mm (Fig. 1). The functional examination revealed an anterior tongue thrusting while swallowing and no centric relation-centric occlusion slide was observed. Assessment of the smile revealed non-consonant smile with approximately 60% of the central incisors visible.

The lateral cephalometric radiograph in centric occlusion revealed skeletal Class II relationship (ANB = 7.4°) with vertical growth pattern (SN-GoMe = 47.7°) and downward and backward rotation of the mandible (NS-Ar-GoGn = 407.8°) (Fig. 2). Jarabak ratio was 55%. All these parameters were suggestive of skeletal open bite.

Treatment objectives

After a detailed evaluation of the case history, clinical examination, and evaluation of study models and radiographs, the following treatment objectives were established:

Closure of the anterior openbite.

Elimination of tongue thrust habit.

Correction of crowding in the anterior segment of both arches.

Enhancement of smile esthetics.

Treatment alternatives

The presence of skeletal openbite, downward and backward rotation of the mandible with a steep mandibular plane would ideally suggest a combination of orthodontics and orthognathic surgery but the patient declined any surgical intervention and requested non-surgical options.

The use of the multiloop edgewise archwire technique (MEAW) with curvature in the archwire accompanied by vertical anterior elastics could address the anterior open bite and correct the inclination of the occlusal plane and mandibular rotation. Similarly, conventional fixed brackets with temporary anchorage devices (TADs) for the intrusion of the posterior segment can address the chief complaint and fulfill our treatment objectives. However, the patient did not want any metallic display of the appliances and asked for esthetic alternatives. Clear aligner therapy was the only esthetic treatment proposed to the patient.

Treatment progress

The treatment was started with clear aligners from Spark aligners (manufactured by Ormco, advanced clear aligner technology with TruGen™ materials) in both the upper and lower arch. To have a predictable clinical outcome for open bite correction, we used 3D controls in the virtual simulator (Spark Approver).

Fig. 2. *Pretreatment lateral cephalogram and orthopantomogram.*

The treatment plan involved two phases. In the first phase, maxillary second molars were compressed by palatal crown torque and derotation was done with distal-in to achieve an oval arch form. Similarly, the mandibular second molars were compressed by lingual root torque and derotation was done with distal-in. The maxillary and mandibular first molars and premolars were expanded with mesial-out. Asymmetric intrusion of the maxillary right posterior segment was done with inter-radicular screw placed between 15 and 16 to achieve a correction in the cant of the occlusion. Maxillary and mandibular anterior teeth were extruded and proclination was done to relieve the remaining crowding. All these movements were done at the same time.

In the second phase, absolute extrusion of the anterior teeth was executed using lingual buttons in the maxillary anterior teeth from 13 to 23 and labial buttons in the lower anterior teeth from 33 to 43 (Fig. 3). The patient was asked to wear the elastics 6 hours per day and these elastics were used for 2.5 months.

The lingual root torque of lower second molars was compensatory to avoid increasing the curve of Wilson, which could increase by non-desired lingual crown torque. The second molars have been utilized to increase anchorage and it was the key to obtaining simultaneous movements in the upper and lower arches. The patient was instructed to wear each aligner for 22 hours per day and to move on to the next one in the series after seven days. After achieving a stable and coordinated occlusion with 60 sets of aligners, non-invasive direct restoration using BOPT and composite resins on anterior teeth was performed, with no dental preparation. The purpose of this restoration was both aesthetic and functional: to resolve the Bolton's discrepancy and to provide adequate proportions of teeth to get symmetric canine and protrusive guidance.

Treatment results

At the end of the treatment, the crowding of the maxillary and mandibular anterior teeth was relieved, and a good overbite was achieved. The correction of open bite was mainly attributed to the extrusion of both maxillary and mandibular incisors and intrusion of maxillary right posterior teeth. The intrusion of the posterior teeth led to counterclockwise rotation of the mandible leading to improvement in the anterior open bite and a decrease in lower anterior facial height.

The post-treatment cephalometric analysis (Fig. 4) showed the reduction of Sn-GoMe angle from 47.7° to 42.5°. The reduction in this angle shows counterclockwise rotation of the mandible due to intrusion of maxillary posterior segment. This on the other hand reduced the sagittal skeletal discrepancy as shown by the change in ANB angle from 7.4° to 5.4°. The overbite increased from -2mm to +2mm and there was an improvement in the maxillary incisor exposure during smile (Fig. 5). Finally, the esthetic appearance of the anterior teeth was further improved with the non-invasive restoration. The patient was prescribed to wear Spark retainer made with Trugen XR material every night.

Fig. 3. *Mid-treatment intra-oral photographs. In the second phase, absolute extrusion of the anterior teeth was executed using lingual buttons in the maxillary anterior teeth from 13 to 23 and labial buttons in the lower anterior teeth from 33 to 43. The photo was taken with open mouth.*

Patient perspective

After treatment with aligner, the smile is more esthetically pleasing, and she now feel more c omfortable in speaking and smiling openly during social interactions.

DISCUSSION

A treatment plan is formulated after a careful analysis of case history, clinical examination findings, study models, and radiographs; however, it remains incomplete if we fail to incorporate the patient's expectations and preferences. Orthodontics with orthognathic surgery would be the ideal treatment option for this type of malocclusion but the patient did not want to undergo procedures under general anesthesia and preferred for esthetic appliance.

Fig. 4. *Post-treatment radiographs.*

Fig. 5. *Post-treatment extra-oral and intra-oral photographs.*

Hence, incorporating patients' values in the clinical practice, we planned for orthodontic camouflage with clear aligners and TADs.

After the clear aligners were first approved for use in orthodontic treatment in 1998, the system gained wide popularity owing to the esthetic nature of the appliance and lesser discomfort compared to the metallic components of the traditional fixed appliance (7). Clear aligners were initially tried on simpler cases and several limitations of different types of tooth movements were reported in the literature with discrepancies between the predicted and actual outcomes (8, 9). With updates in the technologies, incorporation of adjuncts like attachments, power arms, bootstraps, bone-supported expanders and TADS, clear aligner therpay has been successfully used in patients with complex skeletal malocclusion (10).

The aligners used in the management of this case helped to intrude the posterior teeth and control the vertical dimension. This contrasts with the effect seen with traditional fixed orthodontic therapy that tends to aggravate the open bite owing to the extrusive nature of the mechanics and any use of interarch elastics in such fixed appliance might complicate the situation further (11). Suh et al. also found significant intrusion of molars in 55 out of 69 adults with anterior open bite treated with clear aligners alone (12, 13).

Extrusive movement is considered less predictable with clear aligners and the reason is poor grip of the appliance to the tooth during vertical movement (14). Kravitz et al. found extrusive movement with aligners, but without any attachments, to be only 29.6% accurate to the planned position (15). Similarly, Karras et al. (16) and Rossini et al. (8) reported the accuracy of incisors extrusion to be 47.6% and 30% respectively. Now, with the introduction of recent advancements to the clear aligners, the use of attachments, buttons, power ridges and elastics, it is possible to execute more complex tooth movements and achieve more predictable outcomes. In the given case report, we attached lingual buttons on the palatal surface of maxillary anterior teeth and labial buttons in the lower anterior teeth followed by the use of elastics for extrusion.

In the given patient, the closure of the anterior open bite was due to extrusion of the anterior teeth along with the intrusion of the maxillary posterior teeth with TAD. Pinho et al. reported a case of non-surgical management of skeletal open bite with aligners and TAD that successfully corrected the condition with intrusion of mandibular molar and extrusion of both maxillary and mandibular incisors (17). Mandibular incisor extrusion and anticlockwise rotation of the mandible are considered the main factors that help in the closure of the skeletal anterior open bite (13).

The prevalence of open bite varies widely across the geographical region with a maximum reported to be 35.97% in the South Indian population (18). With awareness to the orthodontic treatment and availability of esthetic treatment options, we expect to encounter a greater number of adult cases of open bite in our clinical practice. A case report of 16-year-old female with skeletal anterior open bite treated with clear aligners and TADs found the results to be stable after 1.5 years (17). Several observational studies also reported successful outcome of mild skeletal open bite cases treated with clear aligners (13, 19). In our case, clear aligners with TAD offered a stable result in non-surgical management of skeletal anterior open bite.

CONCLUSIONS

As demonstrated by this case, clear aligners in combination with TAD can be an effective and predictable treatment approach in complex cases like open bite where orthognathic surgery cannot be done. Non-invasive direct restoration using BOPT can be considered in selected cases for enhancement of smile esthetics after the end of orthodontic treatment.

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Case Report

MANAGEMENT OF TOOTH WEAR AND EXCESS GINGIVA: A MULTIDISCIPLINARY TREATMENT CASE REPORT

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ABSTRACT

This case report presents a successful multidisciplinary approach to managing a complex dental condition involving tooth wear and excess gingiva. Tooth wear and excessive gingival tissue pose both functional and aesthetic challenges, necessitating collaboration among orthodontists, periodontists, prosthetic specialists, dental surgeons, and aesthetic doctors. The patient, a 46-year-old female from Madrid, Spain, with no significant medical history and a chief complaint of desiring veneers for improved dental aesthetics, presented with significant issues related to tooth wear and excess gingiva. The treatment addressed functional concerns and enhanced facial aesthetics by restoring the patient's compromised vertical dimension. Digital smile design facilitated precise planning and patient engagement, and implant placement strategies preserved bone structure and interproximal spaces for long-term oral health. The incorporation of facial aesthetics, including a hyaluronic acid-based lip filler, complemented the dental enhancements, resulting in overall facial harmony. This case report underscores the potential benefits of a comprehensive and collaborative approach to managing complex dental cases. It emphasizes meticulous planning, digital technology, patient-centred care, and informed decision-making as crucial elements in achieving successful outcomes.

KEYWORDS: *tooth wear, excess gingiva, multidisciplinary treatment, clear aligners, periodontics, oral surgery, composite veneers, lip filler*

INTRODUCTION

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The management of complex dental conditions often necessitates a multidisciplinary approach that draws upon the expertise of various dental specialists. Among these challenging cases, the restoration of tooth wear and the correction of excess gingival tissue present unique clinical scenarios that require a comprehensive and coordinated strategy. Tooth wear and excess gingiva can present significant challenges to a patient's oral health and overall well-being. While these conditions can be managed individually, a multidisciplinary approach can provide more comprehensive solutions and improved outcomes (1-3).

Tooth wear, often resulting from a variety of factors including bruxism, malocclusion, and dietary habits, can lead to functional impairment, aesthetic concerns, and compromised oral health (4, 5). Excess gingival tissue, on the other hand, not only affects the aesthetics of the smile but also poses potential challenges in restorative and prosthetic procedures. Managing these concurrent issues demands a well-structured plan that takes into account both functional and aesthetic considerations (1, 6-7).

This case report highlights the successful management of a patient presenting with severe tooth wear and excess gingiva through a coordinated effort involving orthodontic treatment with clear aligners (SPARK), periodontics, oral surgery, composite veneers, and facial aesthetic enhancement with lip filler (8). This case report not only showcases the successful outcomes achieved through a multidisciplinary approach but also emphasizes the importance of a coordinated effort among specialists in achieving comprehensive oral rehabilitation. The successful management of tooth wear and excess gingiva underscores the potential for enhancing both function and aesthetics, ultimately leading to improved patient quality of life (9).

In the subsequent sections, we will present the details of this multidisciplinary treatment approach, including assessments, treatment planning, procedures performed, outcomes, and a comprehensive discussion of the results, which collectively exemplify the effectiveness of a coordinated, patient-centred approach in addressing complex dental conditions.

Case presentation

The patient is a 46-year-old female hailing from Madrid, Spain, with no significant previous medical history and no prior relevant dental treatments. She presents with a chief complaint of desiring veneers to improve her dental aesthetics. Clinical examination and diagnostic assessment revealed significant issues related to tooth wear and the presence of excess gingiva (Fig. 1, 2, Table I). Notably, the patient exhibited a loss of vertical dimension and signs of premature ageing of the teeth, warranting a comprehensive diagnosis of tooth wear and excess gingiva as the primary dental concerns. Notably, there is no present illness to report. Upon clinical and diagnostic examination, it was observed that the patient exhibited wear of her incisors and posterior teeth, primarily attributed to asymmetric bilateral compression. This compression has resulted in the loss of vertical dimension and has prematurely aged her teeth. Additionally, there is an excess of gingival tissue that needs to be addressed as part of her treatment plan.

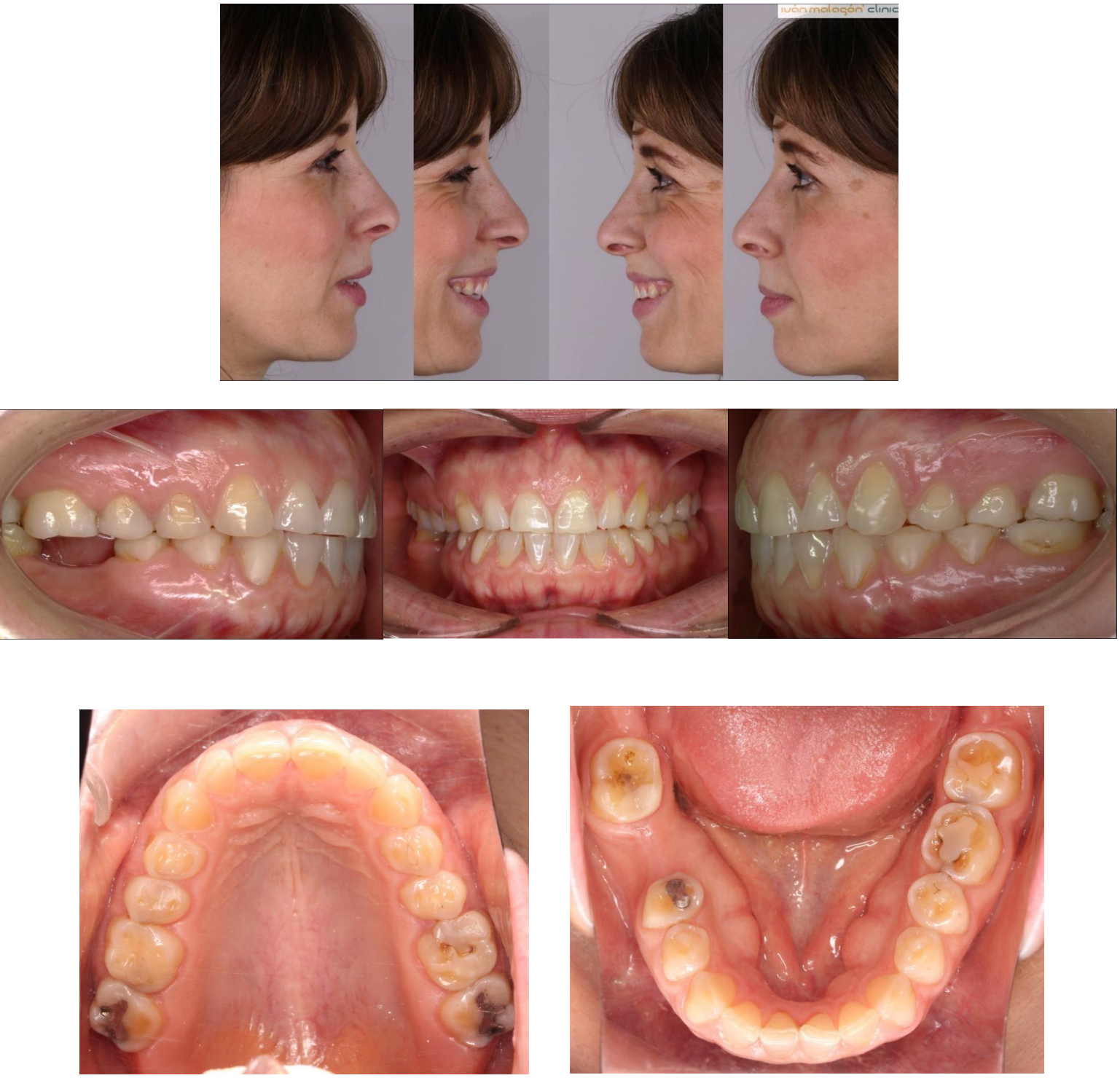

Fig. 1. *Pretreatment intraoral and extraoral images.*

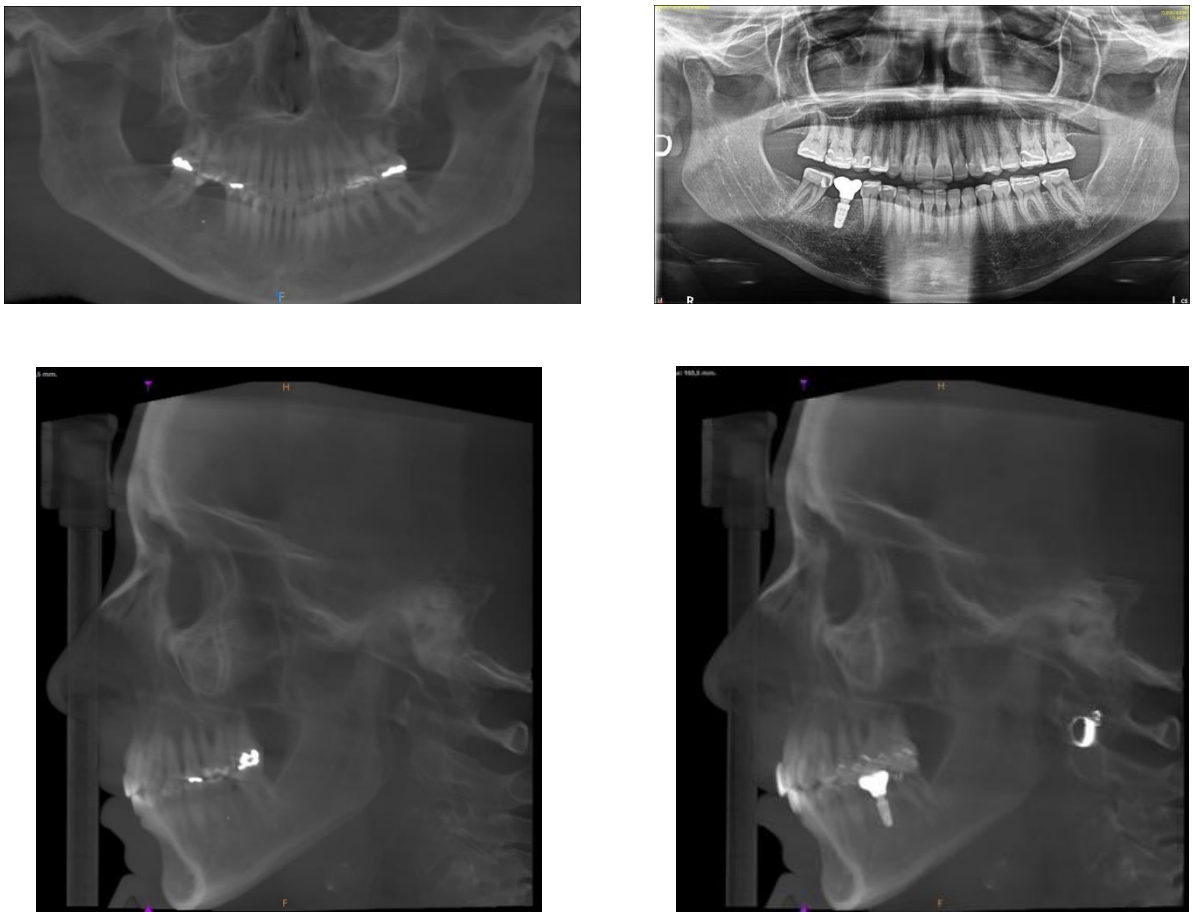

Fig. 2. *Orthopantomography and Cephalometry pre and post-treatment images.*

Table I. *Pretreatment and post-treatment cephalometric analysis.*

Measurement	Norm	Pretreatment	Post-treatment
SNA	**81°**	83.3°	83.1°
SNB	**79°**	77.5°	77.2°
ANB	**2°**	5.8°	5.9°
Gonial Angle	**130° ± 7°**	125°	126.4°
Upper gonial angle	**52° to 55°**	43.8°	44.9°
Lower gonial angle	**70° to 75°**	81°	81.5°
NS-Ar-GoGn	**396°**	403.3°	402.9°
SN-GoMe	**32°**	43.2°	42.9°
U1-SN	**102° ± 2°**	92.73°	92.45°
IMPA	**90° ± 3°**	90.58°	91.03°
Interincisal angle	**135°**	133.66°	133.65°

Treatment approach

The primary objective of the treatment plan is to regain the patient's vertical dimension and create pre-prosthetic clearance, paving the way for a comprehensive rehabilitation phase. At this crucial juncture, the orthodontist assumes a pivotal role in establishing the foundation for the final dental work. Addressing the patient's incorrect occlusion is paramount, as proceeding with crowns at this stage would likely prove unsuccessful due to the existing misaligned forces, potentially exacerbating vertical bone loss. Signs of instability, such as intraoral exostoses resulting from severe occlusal trauma, are already evident in the patient's mouth, underscoring the urgency of intervention. The treatment plan encompasses the alteration of vertical, transverse, and anteroposterior dimensions, followed by comprehensive rehabilitation aimed at achieving well-distributed occlusal forces to ensure the stability of the stomatognathic system and a favourable therapy prognosis.

The multidisciplinary team comprises several specialists, each playing a distinct role in the treatment process. The periodontist is responsible for gingivoplasty to address gingival concerns. The prosthetic specialist is tasked with creating veneers, while the dental surgeon handles implant placement. Additionally, the aesthetic doctor plays a crucial role in optimizing facial proportions, particularly enhancing the projection and thickness of the upper lip to cover a greater amount of gingiva during smiling.

This comprehensive approach was necessitated by the patient's high aesthetic expectations. After a meticulous digital assessment of the patient's smile, it was determined that the most suitable course of action would involve orthodontics, followed by gingivectomy, veneers, and aesthetic medicine. This multidisciplinary approach is crucial in ensuring the attainment of the best possible results, a guarantee achievable only through the collaboration of various specialized professionals.

TREATMENT PROCESS

Orthodontic Treatment with Clear Aligners (SPARK)

In the initial orthodontic phase, the treatment strategy focused on several key aspects. First, there was an expansion of the posterior sectors, specifically the molars and premolars, which was carried out in conjunction with the proclination of the anterior sectors. Importantly, this complex orthodontic manoeuvre was accomplished without the use of mini-screws, highlighting the effectiveness of the treatment approach. Within this phase, particular attention was given to the second molars. Rather than intruding on them directly, they served as guides for the overall intrusion process, effectively marking the desired vertical dimension.

The orthodontic treatment, conducted using aligners, spanned a duration of 3 and a half months. During this period, a remarkable 12 degrees of coronal-vestibular torque were applied, leading to an impressive 2 mm of intrusion per arch. This translated to a total of 4 mm of intrusion across both the upper and lower arches, providing the necessary pre-prosthetic free space (Fig. 3). This approach ensured that our prosthetic colleagues would have adequate space to work with, eliminating the need for the removal of healthy tooth structure. This conservative technique not only facilitated the subsequent prosthetic phase but also preserved the patient's dental integrity.

Ultimately, this comprehensive orthodontic strategy successfully achieved the intrusions required for both the anterior and posterior sectors while optimizing the distribution of spaces between contact points. This not only improved the Bolton discrepancy but also ensured ample room for posterior reconstructions, aligning with the overarching goal of comprehensive dental rehabilitation.

Fig. 3. *Post orthodontic treatment image.*

Dental aesthetic phase (gingivoplastic & composite veneers)

In the subsequent dental aesthetic phase, which involved gingivoplastic procedures and the application of composite veneers, a meticulous and patient-centric approach was followed. At this stage, the smile was studied virtually, allowing for precise planning of the smile's design and the proportions that the teeth should exhibit. This digital planning ensured that the final result would align perfectly with the patient's expectations and aesthetic preferences.

The gingivoplasty, a critical component of this phase, was skillfully performed by the dental surgeon, with the added support of a surgical ferula provided by the orthodontist. This collaborative effort ensured not only the aesthetic enhancement of the gingival tissues but also the overall harmony of the patient's smile.

Once the surgical procedures were completed, and the tissues had healed as intended, the prosthetic phase was initiated. During this phase, the utilization of a mock-up, created with resin, played a pivotal role. This mock-up allowed the patient to experience their "new teeth" practically and tangibly (Fig 4). It facilitated a crucial trial period where the patient could assess the functionality and aesthetics of the proposed dental changes. This hands-on approach ensured that the patient felt comfortable and confident in their outcome, aligning both functionally and aesthetically with their desires and expectations.

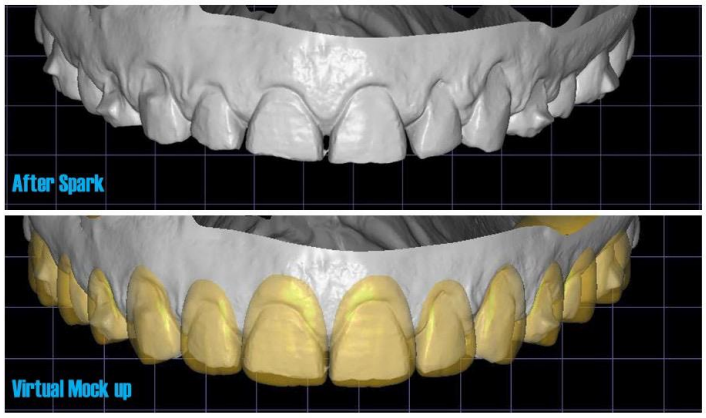

Fig. 4. *After orthodontics treatment and virtual mock-up photographs.*

Oral surgery (implant on tooth 46)

The placement of dental implants played a crucial role in reactivating the functionality of the bone under occlusal loads. This strategic implant placement was designed to prevent the extrusion of the antagonist elements and the closure of the interproximal space by adjacent elements. Moreover, it served the important purpose of averting complications such as herniation of the tongue and cheek, which can sometimes attempt to compensate for empty spaces left by missing teeth. This meticulous implant placement strategy not only restored dental function but also ensured the long-term stability and health of the patient's oral cavity, contributing to a successful overall treatment outcome.

Facial aesthetic

As part of the facial aesthetic enhancements, a specialized procedure was conducted using a hyaluronic acid-based lip filler from Allergan's renowned "Juvederm" line. Employing a vertical injection technique, the aim was to augment the volume of the upper lip with precision. This augmentation served the dual purpose of delicately covering the gums and a portion of the teeth, achieving a more harmonious overall result (Fig 5). Additionally, this technique was instrumental in refining the proportions of the lower third of the face, contributing to a balanced and aesthetically pleasing facial appearance.

Fig. 5. *Post-treatment photographs: orthodontics, gingivectomy, veneers, and lip filler.*

RESULTS

The multidisciplinary treatment approach employed in the management of severe tooth wear and excess gingiva yielded remarkable and comprehensive outcomes. The results encompassed various aspects of oral health, function, aesthetics, and overall patient well-being (Fig. 6).

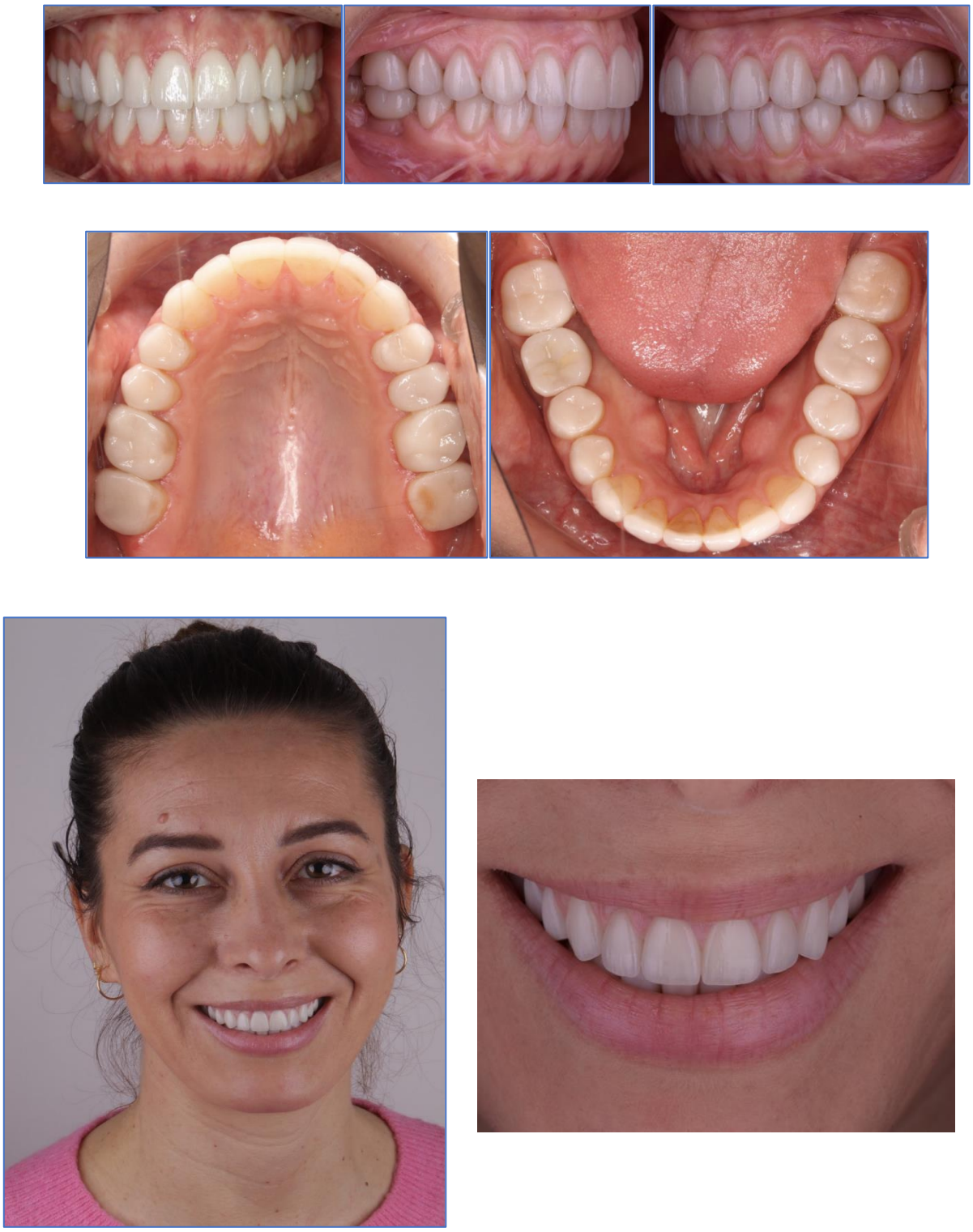

Fig. 6. *Post-treatment photographs: orthodontics, gingivectomy, and veneers.*

The treatment outcomes achieved were nothing short of comprehensive and aligned seamlessly with the established treatment plan. Following the orthodontic phase, significant changes were observed in the vertical, transverse, and anteroposterior dimensions, precisely as intended. This set the stage for prosthetic rehabilitation, during which the achievement of well-distributed and homogeneous occlusal forces was a key success. This optimization was essential for the proper functioning of the stomatognathic systems and contributed significantly to a favourable prognosis.

Furthermore, the subsequent stages of the treatment, including gingivoplasty, the application of veneers, and the hyaluronic acid-based lip filler, resulted in a remarkable enhancement of aesthetics. These interventions not only met but exceeded the patient's aesthetic expectations, aligning perfectly with their specific requests. The comprehensive approach to treatment ensured that both functional and aesthetic aspects were addressed, ultimately delivering a highly successful and satisfying outcome.

DISCUSSION

The management of tooth wear and excess gingiva through a multidisciplinary treatment approach represents a significant stride in contemporary dentistry. This case report highlights the importance of a comprehensive strategy in addressing complex dental issues that encompass functional and aesthetic concerns. In our discussion, we delve into the key aspects and implications of this multidisciplinary approach, emphasizing its significance and potential for widespread applicability.

Our case report demonstrates that a comprehensive and collaborative treatment approach, involving various dental specialists, can lead to successful outcomes. These findings are in line with previous research indicating the benefits of multidisciplinary care in managing complex dental cases (1, 9, 10). By bringing together orthodontists, periodontists, prosthetic specialists, dental surgeons, and aesthetic doctors, we were able to optimize both the functional and aesthetic aspects of the patient's oral health.

The restoration of the vertical dimension in this case was a critical factor in achieving functional and aesthetic success. Our approach aligns with studies that emphasize the importance of addressing vertical dimension changes in comprehensive dental rehabilitation (11,12). Proper management of the vertical dimension not only contributes to occlusal stability but also enhances the overall facial aesthetics and patient satisfaction.

The integration of digital smile design in our case report is consistent with previous research highlighting the advantages of digital technology in treatment planning (13, 14). By virtually assessing the patient's smile, we were able to create a more predictable treatment plan that aligned with the patient's aesthetic preferences.

Furthermore, our case report underscores the importance of patient-centred care and informed decision-making. The use of mock-ups with resin allowed the patient to actively participate in the treatment process, aligning with the principles of shared decision-making advocated in contemporary dentistry (15, 16).

In the realm of implant placement, our approach aligns with studies emphasizing the significance of strategic implant placement for long-term success (17). Preserving bone structure and maintaining interproximal spaces not only restored function but also contributed to the patient's overall oral health.

Finally, the incorporation of facial aesthetics into the treatment plan resonates with studies emphasizing the role of facial proportions in overall treatment success (18). Enhancing the upper lip's volume and addressing facial proportions complemented the dental enhancements, resulting in a harmonious overall facial appearance aligned with the patient's desires.

CONCLUSIONS

In the management of tooth wear and excess gingiva, this multidisciplinary treatment case report highlights the significance of a holistic and collaborative approach in contemporary dentistry.

Throughout this case, we have demonstrated that successful outcomes are achievable when various dental specialists work in tandem to address complex dental issues. In conclusion, our multidisciplinary case contributes to the growing body of evidence supporting the benefits of comprehensive and collaborative dental care. It underscores the significance of meticulous planning, digital technology, patient engagement, and informed decision-making in achieving successful outcomes. This approach not only addresses complex dental issues but also enhances patient satisfaction and overall oral health.

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Informed consent

Informed consent was obtained from the patient for the publication of this case report, including the use of clinical photographs.

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