IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 19, Issue 12 Ser.9 (December. 2020), PP 50-56
www.iosrjournals.org

Orthodontic treatment of Class II Division 2 malocclusion patient: with Pendulum Fixed Appliance and TAD´s for improved anchorage: A case report

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Abstract
The purpose of this article is to present a clinical case report of a 13-year-old patient with a Class II skeletal diagnosis and Class II Div 2 malocclusion, emphasizing the treatment plan, progress, and results obtained from the case, which was carried out with a non-extraction therapy divided into 2 phases. First, the use of a Pendulum Fixed Appliance (PFA), followed by therapy with fixed appliances, modifying the anchorage after the PFA with infra-zygomatic mini-screws (TAD´s) for improved skeletal anchorage.

Keywords: *Class II , Distalization , Pendullum, TAD´s*

Date of Submission: 06-15-2020 Date of Acceptance: 21-12-2020

I. Background

Nowadays is a very important goal for orthodontic treatment not only to provide the patient with a functional result but also to provide an aesthetic and efficient treatment. The smile is considered the gateway to human relationships, for this reason, Orthodontists must use all resources to achieve this task. Orthodontists must take into consideration: occlusion that includes not only the relationship and interdigitation of the teeth but also the relationships of the teeth with the soft and hard tissues that surround them. As known, the key to a successful treatment is based on the recognition of the occlusal problems, and more important is to determine the best treatment approach. Class II division 2 malocclusion should be considered not only as a complex dentoalveolar problem but also as a condition that affects considerably patients profile. Clinically, this type of malocclusions is characterized by specific dental-skeletal and soft-tissue characteristics: retroclination of the maxillary incisors and proclination of the lateral incisors are generally associated with mesofacial or brachifacial biotype, characterized by a protrusion of nose, a decrease in the lower third of the face, retruding lips, protruding nose and chin which causes a concave profile[1,2]. The correction of class II can be hindered by molar distalization, obtained with non-compliance therapy that involves the use of appliances that minimize the need for such cooperation and attempt to maximize the predictability of results[3]. This kind of treatment approach should take into consideration several effects that may help or affect negatively the patient's treatment, base on the specific characteristic of the patient:

- Molar distalization produces a downward and backward mandibular rotation, in a clockwise direction
- An increase in the anterior facial height especially on the lower third
- Increase on the mandibular plane angle[4,5]

In order to accomplished molar distalization, various non-compliance fixed orthodontic devices had been propose. Such as the Pendulum[6], the Distal Jet, the Carriere Motion are among the most used, with a minimal variability of molar distalization and disto-inclination[3]. The pendulum fixed appliance (PFA) was first reported by Hilgers in 1992, Pendulum fixed appliance consists of an acrylic palate as an anchorage unit to distalize the first molars, distalization arms or springs are constructed from 0.6 mm stainless steel round wire or Titanium Molybdenum Alloy (TMA) that consists of a closed helix and a U-loop. The purpose of the closed helix is to allow for activation of the distalization arms. The U- loops are incorporated mesial to the molars to

allow for adjustment of the axial inclination during distalization. This wire can be directly solder into de molar bands or it can be activated by simply engaging the wire into the lingual boxes soldered to the molar bands. Typically, the initial activation of 60° to 70° will generate 250g of force per side. As mentioned before, the pendulum fixed appliance is indicated for Non-extraction treatment of Class II Div. 2 malocclusion, in cases where the face profile of the patient could be compromised by extraction orthodontic therapy. It also can be applied during mixed or permanent dentition providing an excellent and efficient molar distalization in a short period of time according to Hilgers, a clinician can achieve up to 5 millimeters of molar distalization[6]. Besides, the use of temporary anchorage devices (TAD) in orthodontics has improved and facilitated the biomechanics in several treatment approaches, providing an excellent tool to prevent at the maximum the loss of anchorage, especially when used after non-extraction orthodontic therapy by molar distalization[7,8].

The purpose of this article is to present a clinical case report of a 13-year-old patient with a Class II skeletal and Class II Div 2 malocclusion, treated with a non-extraction approach by molar distalization using Pendulum Fixed Appliance (PFA), followed by therapy with fixed appliances with modified anchorage after the PFA with infra-zygomatic mini-screws (TAD´s).

II. Case Report

A 13-year-old female patient came to the office requesting orthodontic treatment, to correct the position of her front teeth and improve her smile (***Fig. 1***). At the initial clinical inspection, it was observed that the patient had previous treatment with anchoring devices (transpalatal arch and lingual arch) as space maintainers, the patient reported having had previous treatment with the pediatric dentist years ago.Cephalometric analysis according to Steiner, showed the patient with a Class 2 skeletal pattern by a 5.3º ANB, caused by a protruding maxilla; the patient also presented a high mandibular plane angle MP-SN 35.7º. Dentally the upper incisors were retroclined U1-SN 97.7º concerning the norm. Clinical evaluation of the patient revealed a straight profile, with the lower third slightly diminished, the nasolabial angle straight and both the upper and lower lips were slightly retruded to the E plane of aesthetic reference, by - 1.8 mm and - -1 mm respectively (***Fig 2***). At the clinical oral examination, the patient exhibited a permanent dentition with a Class II Div 2 malocclusion, a Class II molar and canine relationship, the presence of the retroclined upper central incisors, accompanied by a pro-inclination of the lateral incisors, properly characteristic of the malocclusion. The patient showed moderate crowding in the anterior mandibular and maxillary area. The overjet was at 1 mm and overbite of 3.0 mm. Maxillary dental midline was align and apparently coincident with the facial midline. The third molars are in the process of eruption. According to the radiographic evaluation, the patient is located in stage 2 of development[9], according to the process of vertebral oscillation, with which it is determined that the patient still has certain growth potential. Finally, the patient presents good hygiene and stable periodontal health to be able to begin orthodontic treatment.

Treatment Plan

General objectives

Among the objectives to be fulfilled in the treatment plan, it was established not to modify the profile through a non-extraction orthodontic therapy for correction of a Skeletal Class II and a Class II Div. 2 malocclusion, for this reason, it was decided to carry out the treatment in 2 phases. Within the first part of the treatment, it was decided to perform the upper molar distalization using a Pendulum (PFA)[6], to correct the molar Class II, freeing the crowding and without affecting the profile of the patient. Once the Class I molars were established, it was decided to continue with the fixed appliance phase. Unlike the traditional protocol applied after a distalization process, instead of the subsequent anchoring using a Nance button, it was decided to use temporary anchoring devices (TAD's), 2 x 12 mm infrazygomatic mini-screws (© TD Orthodontics, México), since anchorage control was one of the most important keys to the success of our treatment. The use of mini implants in orthodontics offer many advantages as temporary anchoring devices since they are generally easy to place and remove once the biomechanics is completed, they can be immediately loaded, they are versatile and provide effective anchoring without the need for cooperation of the patient [10].

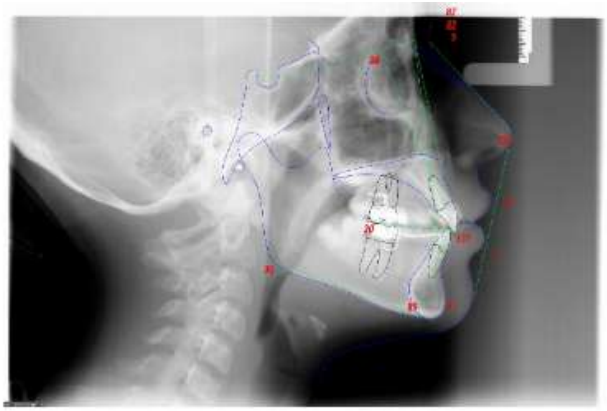
Treatment progress

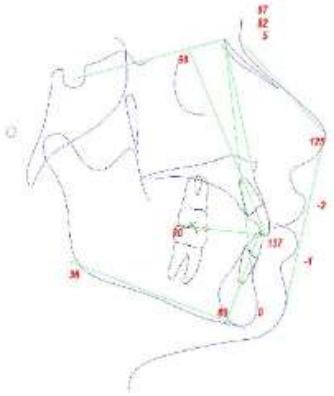
Before starting with the treatment protocol established for our patient, it was decided to withdraw the previous treatment of space maintainers that the patient had.During the first phase of the treatment which was carried out using a Pendulum (PFA), for the correction of molar Class II by molar distalization.The PFA appliance was fixed-up to the bicuspids with composite, constant activation of 250 gr. per side was generated by engaging the U-loops into the lingual boxes previously soldered to the first upper molar bands. This made it

easy to verify accurate activation of the U-loops for maximum results. The U-loops were made of titanium molybdenum alloy (TMA) caliber 0.032"(Ormco de Mexico S.A. de C.V.)[6]. The PFA check-up and activation appointments were made monthly, for an established period of 5-6 months, a period in which a molar distalization of approximately 6 mm was achieved, It was sought to obtain an over correction in the molar position up to a CIII molar relationship (***Fig. 3***), thus managing to establish molar bilaterally relationship, keeping our maxillary and mandibular anterior segment stable, in order to avoid a possible negative effect on the patient's profile.

Once the amount of molar distalization necessary to establish the molars in Class I had been obtained, it was decided to remove the PFA. After removing the PFA, 2 x 12 mm (© TD Orthodontics, México)infrazygomatic mini-screws (***Fig 4***) were placed together with the MBT Slot 0.22 " fixed appliance (©American Orthodontics, USA), to begin the alignment and leveling in the upper arch. At the same time, a power-chain was placed in the maxillary canines, in order to fulfill our 2 fundamental objectives: maximum retention of anchorage and continue with a sequential distalization phase in the upper arch, in which premolar were included until reaching the anterior superior segment.

Fig1. *13-year-old Patient with Class II Div 2 malocclusion, exhibited molar and canines Class II, with a cusp to cusp relationship.*





Group/Measurement	Value	Norm	Std Dev	Dev Norm
Interincisal Angle (U1-L1) (°)	137.2	124.0	6.0	2.2 **
IMPA (L1-MP) (°)	89.4	95.0	7.0	-0.8
ANB (°)	5.3	1.6	1.5	2.5 **
Lower Lip to E-Plane (mm)	-1.0	-2.0	2.0	0.5
Upper Lip to E-Plane (mm)	-1.8	-4.0	2.0	1.1 *
MP - SN (°)	35.7	33.0	6.0	0.5
SNA (°)	87.2	82.0	3.5	1.5 *
SNB (°)	81.9	80.9	3.4	0.3
U1 - SN (°)	97.7	103.8	5.5	-1.1 *
Occ Plane to SN (°)	20.2	14.4	2.5	2.3 **
L1 - NB (mm)	3.5	4.0	1.8	-0.3
U1 - NA (mm)	-0.0	4.3	2.7	-1.6 *
U1 - NA (°)	10.5	22.8	5.7	-2.2 **
L1 - NB (°)	26.9	25.3	6.0	0.3
Pog - NB (mm)	0.5	2.4	1.7	-1.1 *
Soft Tissue Convexity (°)	124.8	137.0	4.0	-3.0 ***

Fig 2*. Cephalometric analysis: Steiner*

It was determined to continue with the molar distalization mechanics, utilizing the mini-screws and power-chains, with the purpose of generating a Class III molar overcorrection, assuming that in any treatment despite the use of temporary skeletal anchorage devices, eventually a certain amount of anchorage may be lost [8,11]. The lower fixed appliances continued to align and level the lower arch. During this process, the sequence of arch-wires used was from a NiTi 0.14 arch-wireup to a 0.19x0.25stainless steel arch-wire, which would allow torque to be effectively expressed in the anterior segment. During the completion stage, it was decided to place power-arms (***Fig 5 C***) in the anterior superior segment that would allow to retractanteriorteeth and consolidate the optimal overjet relationship, according to Ozaki[12],controlled anterior

tooth movementssuch as the controlled tilt of the lingual root, body movement and controlled lingual crown tilt. Controlled lingual root tilt is the type of tooth movement in which the tooth is tilted around its incisal edge as the center of rotation (CRo), which can be obtained by using power-arms and in addition to this a slightly Spee Curve bend was applied to 0.19 x.025 SS arch-wire during the anterior retraction movement.

Treatment Results

According to the initial treatment plan, the previously established objectives were satisfactorily achieved, with which an excellent functional and aesthetic result was obtained for the patient. Whose principal complaint was satisfactorily solved, managing to incorporate misaligned anterior teeth and obtaining a very pleasant smile. As established in the initial treatment plan, with the distalization mechanics using the fixed pendulum device (PFA) was possible to correct the Class II malocclusion and clear the anterior crowding, without compromising the facial appearance or the patient's profile, unlike if it had been treated with dental extraction therapy. In our case, the changes in the patient's profile were minimal, due to the favorable growth of the patient and the type of biomechanics used in the treatment. Cephalometrically, once the Pendulum Fixed Appliance was removed (**Fig 6**), no significant changes were observed in the skeletal pattern of the patient, which continued with a Class 2 pattern due to an ANB of 5.5º, the angle of the mandibular plane was slightly elevated MP-SN 37, 7º whose variation was specifically associated with the molar distalization process [13].

Dentally, the upper incisors suffered a slight proclination compared to the start of treatment 99.1º U1-SN. The clinical evaluation of the patient favorable profile changes, with a slightly more convex profile, with the lower third in better preference, keeping the nasolabial angle straight and both the upper and lower lips slightly retracted to the E plane of aesthetic reference, in - 1.9 mm and -1.9 mm respectively (**Fig. 7**).

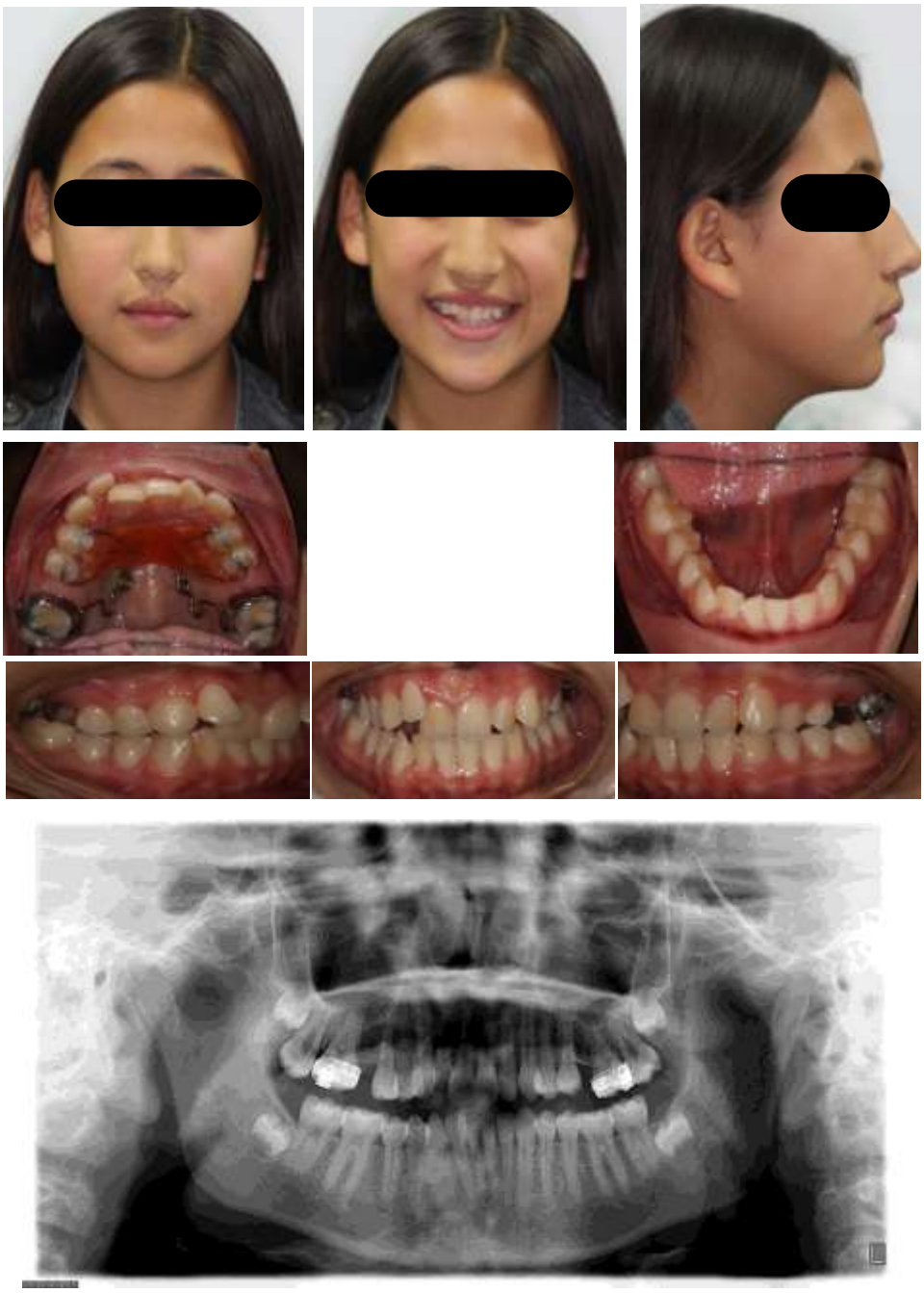


Fig. 3. *Molar distalization obtained after the use of PFA, in an approximately 5-6 months, constant activation U-loops was applied to generate 250 gr. per side, total distalization of 5-6 mm was achieved. Molar Class I was established.*

Fig. 4. *Placement of two infrazygomatic mini-screws 2 x 12 mm (*© TD Orthodontics, México*), along with close-coil and a power chain to maintain anchorage and improved molar distalization.*

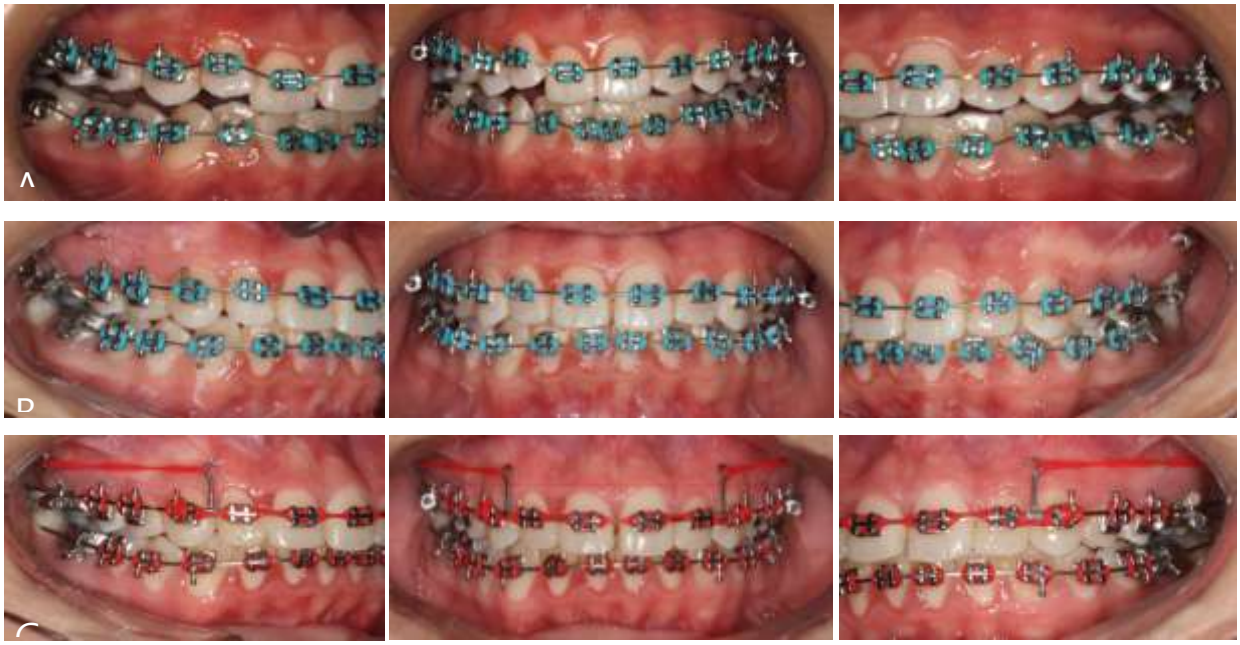


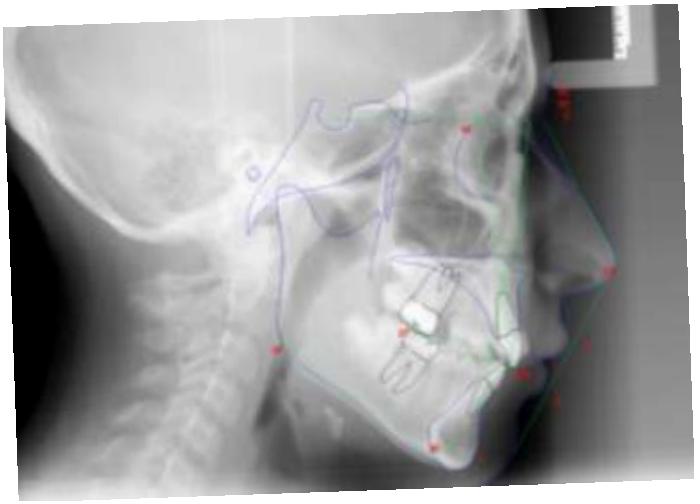
Fig 5*. A)Complete fixed appliances MBT slot 0.22 "in both arches; B) Alignment and leveling; C) Detail phase: Arches 19x25" SS, retraction of the upper anterior teeth using mini-screws + power-arm + Slightly Spee Curve bend, to establish adequate overjet ratio with an efficient and controlled movement.*

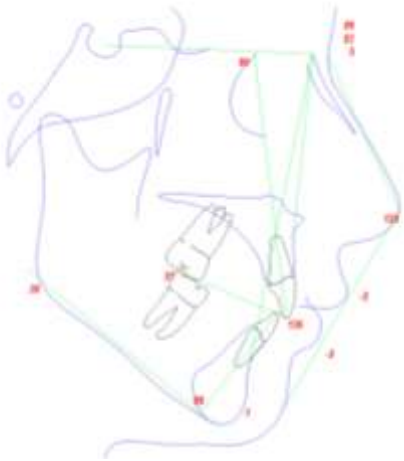
III. Discussion

The correction of Class II malocclusion has always been a challenge in Orthodontics. Distal movement of maxillary first molar is a common goal in the treatment of a Class II molar relationship. The mechanics used to apply the force required to distalize the maxillary first molar include ”noncompliance appliance”, which eliminate the need for patient cooperation to activate the force system such as pendulum fixed appliance. Sujatha Paranna *et al.* [14]stated that the patient tolerance of the pendulum appliance is excellent. It is simple and easy to fabricate, with minimal laboratory support. The cost of a pendulum appliance is a fraction of the cost of commercially available molar distalization appliances. Shashidhar [15] evaluated dentoalveolar effect of distalizing appliances, in which he found 4.93±1.68mm in Pendulum group over a period of six months at a mean monthly rate of 1.1mm/month; Hilgers[6] showed a 5 mm of distal molar movement in a 3 to 4 months period of time. In the same study, as known in cases with intra-oral molar distalizing appliances, the anchorage is generally taken from palate appliance such as Nance button in combination with Clase II elastics, nevertheless

incisors moved mesially by 1.57±0.58 mm in pendulum group. Recently, skeletal anchorage devices have been applied to achieve molar distalization and mass retraction with decreased side effects and decreased dependence, to overcome the loss of anterior anchorage, a bone-anchored pendulum appliance has been introduced, but there is still an issue with distal tipping ofthe molars. To avoid anchorage loss, in our case mechanics using mini-screws were applied [15-17]. Skeletal anchorage-assisted upper molar distalization has become one of the standard treatment modalities for the correction of Class II malocclusion[18].

Molar distalization is often associated with adverse effects such as anchorage loss and uncontrolled tipping, the pendulum type appliance produced significant distal tipping of the maxillary molars during distalization.





Group/Measurement	Value	Norm	Std Dev	Dev Norm
Interincisal Angle (U1-L1) (°)	135.5	124.0	6.0	1.9 *
IMPA (L1-MP) (°)	87.7	95.0	7.0	-1.0 *
ANB (°)	5.5	1.6	1.5	2.6 **
Lower Lip to E-Plane (mm)	-1.9	-2.0	2.0	0.0
Upper Lip to E-Plane (mm)	-1.9	-4.0	2.0	1.1 *
MP - SN (°)	37.7	33.0	6.0	0.8
SNA (°)	86.3	82.0	3.5	1.2 *
SNB (°)	80.8	80.9	3.4	-0.0
U1 - SN (°)	99.1	103.8	5.5	-0.8
Occ Plane to SN (°)	20.6	14.4	2.5	2.5 **
L1 - NB (mm)	4.9	4.0	1.8	0.5
U1 - NA (mm)	0.4	4.3	2.7	-1.4 *
U1 - NA (°)	12.8	22.8	5.7	-1.7 *
L1 - NB (°)	26.1	25.3	6.0	0.1
Pog - NB (mm)	0.7	2.4	1.7	-1.0 *
Soft Tissue Convexity (°)	124.6	137.0	4.0	-3.1 ***

Fig 6*. Cephalometric evaluation after debunking of PFA*

Mean distal crown tipping of 1.5º occurred during a mean distalization of 1.8 mm, which equates to approximately 0.8º distal tipping per 1 mm of distalization. Significant intrusion of the molar during distalization using thependulum type appliance, studies have reported intrusion of the first molar after distalization with the conventional pendulum appliance. In our case, superimposition (***Fig 7-B***) showed the effect of a force applied through PFA towards the upper first molar, evidently a tipping effect along with a distal movement and slightly intrusion of the molars were shown. Subsequent distalization of premolars, canines, and incisors may also have affected the position of distalized maxillary molars. Regarding Skeletall changes, maxilar position remain stable, however the occlusal plane opened as the mandibular plane by 2.40º and lower

anterior facial height increase by 2.9 mm. The mandible rotated down and backward and the overbite decreased[14-18], which in our case improved patients face and profile appearance.

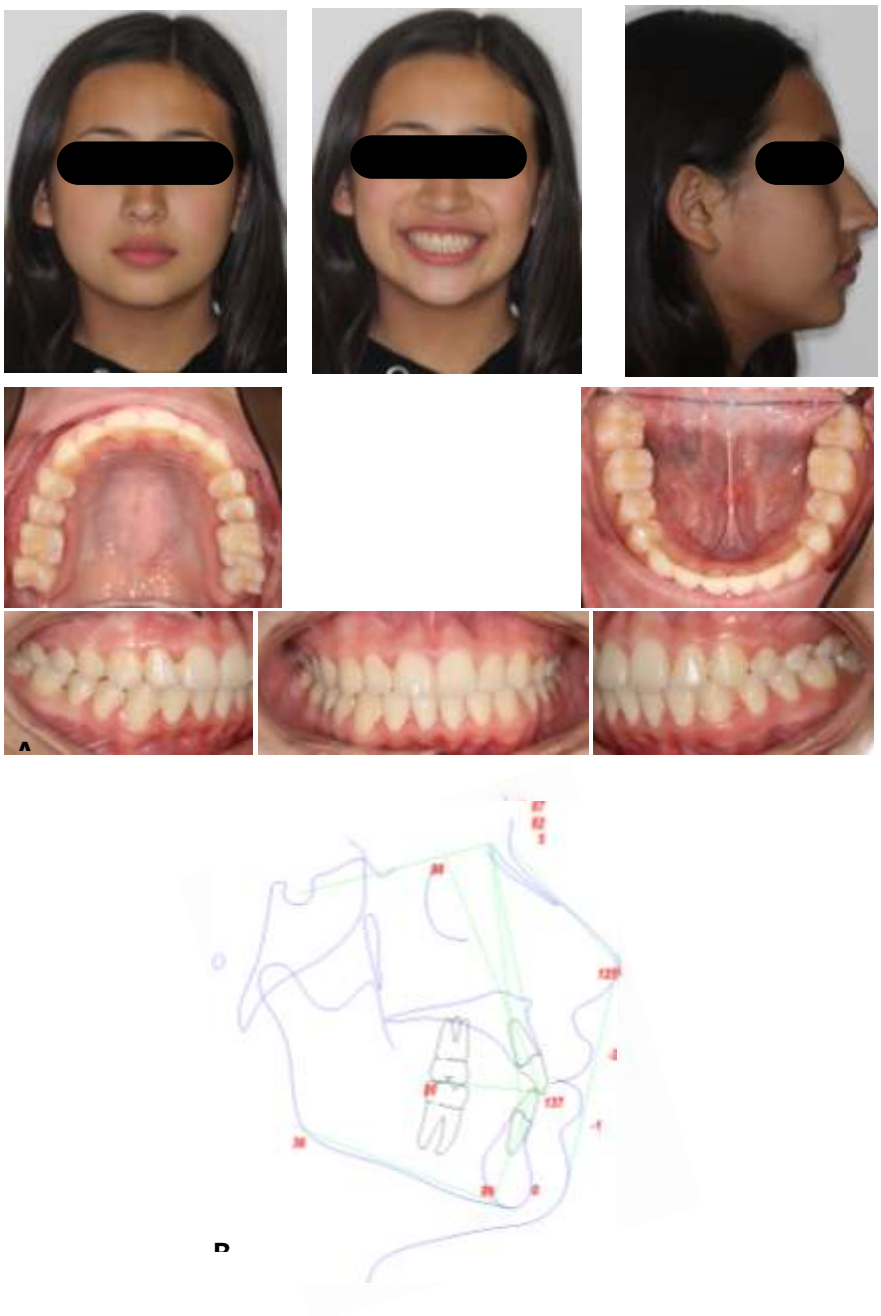


Fig 7. A. *Case outcome showing the fulfillment of the established objectives.* ***B.*** *Cephalometric superimposition.*

IV. Conclusion

The treatment of patients with Class II Div 2 will depend on various factors, however, an adequate diagnosis and treatment plan will be essential to carry out a treatment with the appropriate biomechanics, which allows achieving the ideal results and allows meeting the objectives laid out in the treatment plan. The use of the Pendulum Fixed Appliance (PFA) proved to be an excellent option to achieve the objectives with our patient, achieving an effective distalizing effect for the correction of Class II malocclusion, reducing side effects with the use of mini-screws, facilitating biomechanics, and establishing optimal results for both functional and aesthetic outcome in our patients.

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