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Susana Palma has a degree in Dentistry from the University of Granada subsequently studied postgraduate orthodontics and completed a doctorate at the Complutense University of Madrid. She was an honorary collaborating professor at the Complutense University from 2003 to 2007. She currently teaches postgraduate courses at the University of Salamanca and at the CEPUME of University of Alcalá. Since 2005, she has had a private practice in Ciudad Real, Spain, where she works as a specialist Orthodontist.

Dr. Palma was part of the first cohort of orthodontists certified in Invisalign in Spain in 2001. She received two Peer Awards in 2015 and 2017 and has been an international speaker for Align since 2016, giving national and international conferences.

She is a member of EMEA Teen Speakers group, she has extensive experience in treatments with Invisalign in adolescents, is member of Ortodoncis in Spain and co-director of the master on Invisalign technique at Aligners Academy given nationally and internationally.

Comparative treatment of class II malocclusion using Invisalign treatment with mandibular advancement as an alternative to Herbst connecting rods

Overview

This article shows the efficacy of the Invisalign System with mandibular advancement in skeletal Class II treatment, through comparison with a similar case treated with Herbst connecting rods. In both cases, similar clinical results were obtained, with Invisalign treatment with mandibular advancement being the treatment option with the shortest duration and greatest comfort for the patient. The gradual correction of class II, without excessive interocclusal opening, and the simultaneous correction of dental alignment contributed to increased collaboration in the use of the device by the adolescent. Therefore, in my practice I use the Invisalign System with mandibular advancement as the device of choice to treat class II malocclusion patients with mandibular hypoplasia such as those described here.

This article also includes some clinical tips for optimizing results with the Invisalign System with mandibular advancement and recommendations for proper patient selection.

Introduction

In the treatment of class II, when we want to achieve a skeletal effect, the most important thing is the stage of growth of the patient we choose to make the correction, as shown by various studies collected from the literature on this subject.

Barton S et al.¹ studied those parameters that were determinant when assessing which patients would have a positive response in orthopedic correction with functional devices, and determined that there were four parameters determining the success of this device: having a moderate protrusion up to a maximum of 11 mm, having an increased overbite (with a horizontal growth pattern), being in active growth phase, and being willing to collaborate. This article recommended treatment between the ages of 10-11 for girls and 11-12 for boys.

Patel HP et al.² investigated factors determining the success of functional devices. The results of this study showed that the patients who obtained the greatest skeletal response were those who at the beginning of treatment showed a small, retracted jaw with a decrease in the height of the anterior and posterior cranial base.

In our consultation, in order to assess the ideal moment of treatment, we based on Baccetti T^{3,4} studies in relation to the maturation of the vertebrae. In these studies, the CS3 and CS4 stages are defined as the ideal stage to achieve a greater skeletal response in treatments with functional devices

To carry out the comparative study included in this article, we chose two patients who were at this stage of skeletal maturation at the beginning of treatment. One of the patients was treated with Herbst connecting rods^{5,6,7} and the other with the Invisalign System with mandibular advancement.

Clinical Case #1

Treatment with conventional devices (2x4, Herbst) followed by a second phase with Invisalign Lite.

Patient: Male, 12 years and 8 months old.

Front initial rest



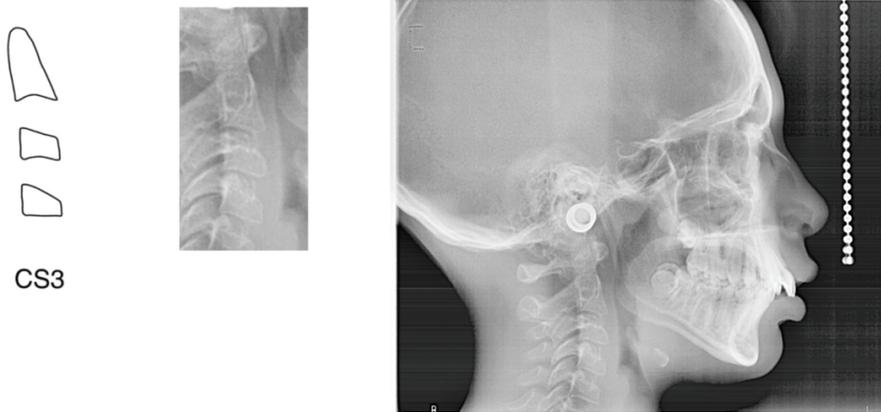
Frontal initial smile



Initial profile



Initial lateral telerradiography of the patient. Stage 3 of maturation in the vertebrae



Initial orthopantomography



Initial right side



Initial front side



Initial left side



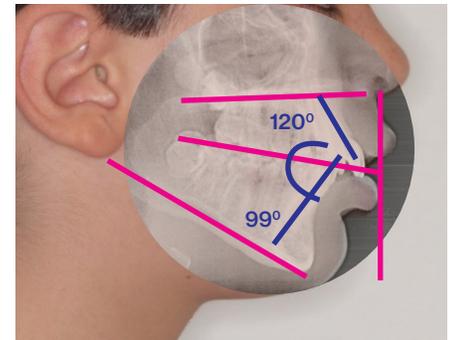
Initial upper occlusal



Initial lower occlusal



Initial cephalometric tracing



Initial cephalometric values



Key cephalometric values

Measurement (degrees)	Initial	Standard	Dev. Typ.
SNA	85	80	2.0
SNB	78	82	2.0
ANB	8	2.0	1.5
U1-SN	99	103	6.0
L1-GoGn	99	93	3.0
Interincisal	120	135	6.0
Sn-GoGn	35	32	4.0

Diagnosis

- a. Class II skeletal with mandibular hypoplasia
- b. Mesofacial growth pattern
- c. Stage 3 of skeletal maturation in the vertebrae, coinciding with the beginning phase of the pubertal acceleration period
- d. Class II teeth first division
- e. Vestibuloversion of upper and lower incisors
- f. 90% overbite

Treatment plan

- 01 2x4 in the upper arch for three months prior to placement of the Herbst, in order to eliminate interference from the upper lateral incisors during mandibular advancement.
- 02 First orthopedic phase with Herbst connecting rods: in order to perform maxillary expansion using the Herbst expansion screw and mandibular advancement through the connecting rods.
- 03 Second phase with Invisalign Lite:
 - **Objective:** Closure of the upper diastemas by maintaining the torque of the incisors
 - **Treatment plan:** Lower IPR from canine to canine, radiculo-palatal torque of the upper incisors during the entire retraction movement. Precision Cuts: 13 and 23 hooks and 36 and 46 button cutouts for class II elastics in order to maintain the mandibular advance position and provide greater posterior anchorage during retrusion of the upper incisors.

Right side after Herbst



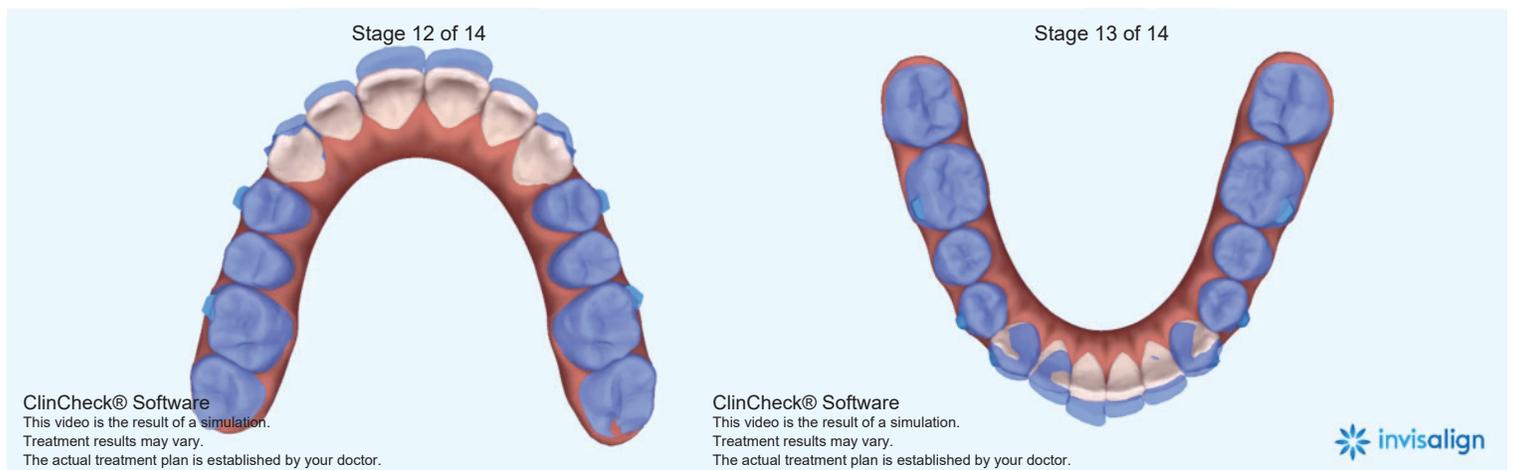
Intraoral frontal after Herbst



Left side after Herbst



Image of the ClinCheck of the Invisalign Lite treatment, showing posterior anchorage for the closing of anterior diastemas applying radiculo-palatal torque to the upper incisors



Final results

Class I molar and bilateral canine, with adequate torque of upper and lower incisors.

Final records

Final right lateral



Final intraoral front



Final left lateral



Final upper occlusal



Final lower occlusal



Final cephalometric values



Key cephalometric values

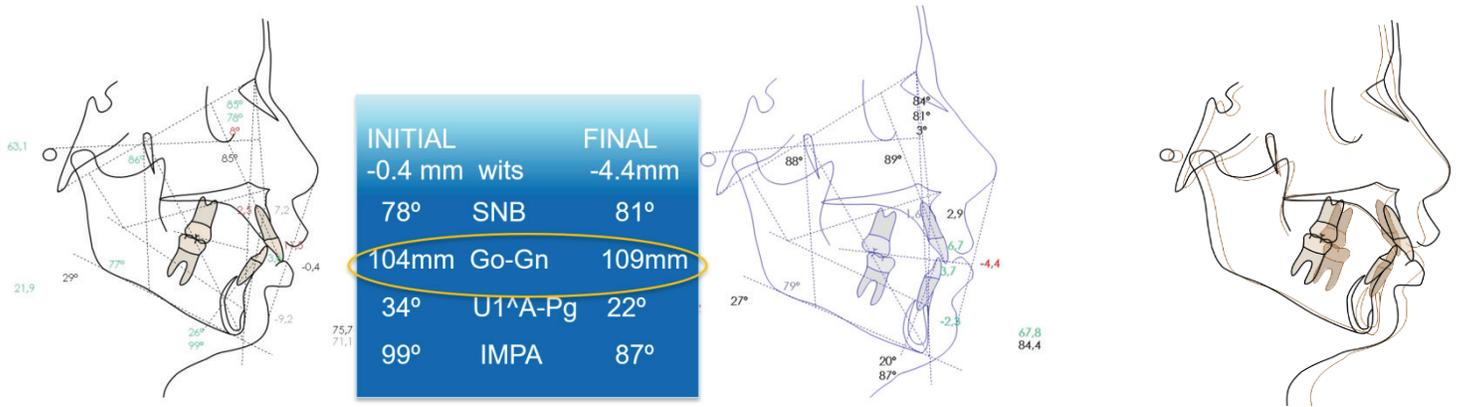
Measurement (degrees)	Initial	Standard	Dev. Typ.
SNA	84	80	2.0
SNB	81	82	2.0
ANB	3	2.0	1.5
U1-SN	100	103	6.0
L1-GoGn	87	93	3.0
Interincisal	139	135	6.0
Sn-GoGn	34	32	4.0

Cephalometric changes experienced

- 5 mm increase in mandibular length and Gonion Gnathion distance
- Rotation of the jaw counterclockwise
- Retroinclination of the lower incisor during retrusion with Invisalign treatment, to compensate for vestibuloversion of the lower incisor after use of Herbst
- No changes were observed in the angle of the mandibular plane

Mandibular changes

Cephalometric overlap



Final right lateral



Final intraoral front



Final left lateral



Clinical Case #2

Invisalign System treatment with mandibular advancement (MA)

Patient: Male, 14 years and 2 months old.

Initial extraoral front



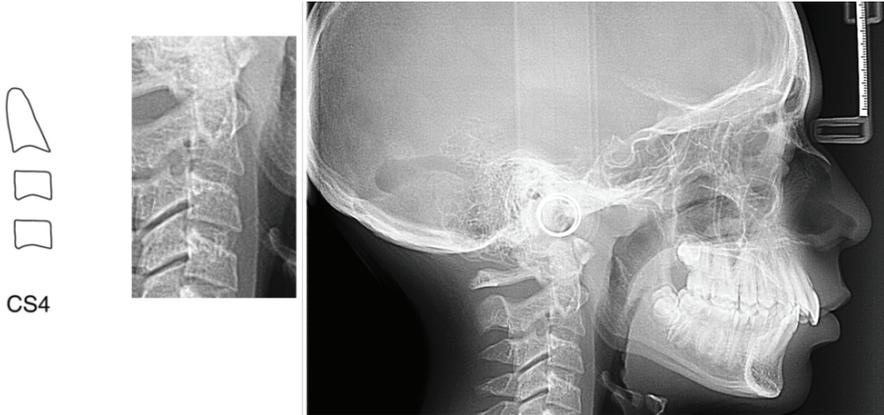
Initial smile



Initial profile



Initial telerradiography and stage of maturation of the vertebrae at the beginning of treatment



Initial orthopantomography



Initial right side



Initial intraoral front



Initial left side



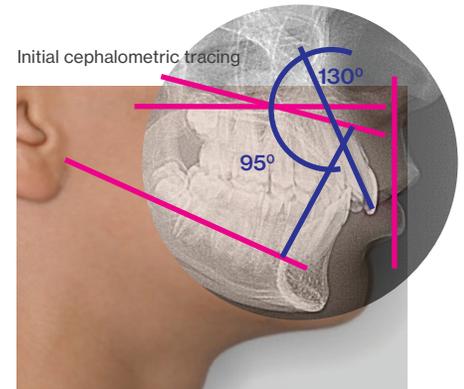
Initial upper occlusal



Initial lower occlusal



Initial cephalometric tracing



Key cephalometric values



Key cephalometric values

Measurement (degrees)	Initial	Standard	Dev. Typ.
SNA	81	80	2.0
SNB	76	82	2.0
ANB	5	2.0	1.5
U1-SN	98	103	6.0
L1-GoGn	94	93	3.0
Interincisal	139	135	6.0
Sn-GoGn	29	32	4.0

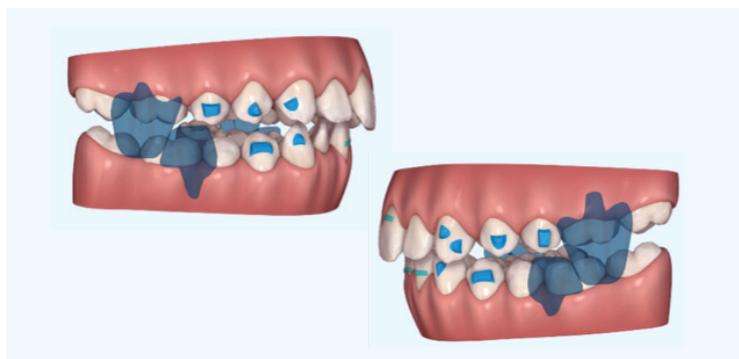
Diagnosis

- a. Class II skeletal with mandibular hypoplasia
- b. Mesofacial growth pattern
- c. Growth stage in the CS4 vertebrae corresponding to the peak of maximum pubertal growth
- d. Class II first division with raised shoulder
- e. Vestibuloversion of upper incisors
- f. Bilateral scissor bite
- g. 90% overbite

Image of ClinCheck showing the different stages of treatment: preview phase in light blue on the animation bar, jaw advance phase in dark blue on the animation bar, transition phase in dark grey on the animation bar.



Visualization of Precision Wings in ClinCheck



Class II elastic placement for nocturnal use of upper canine palate to lower second molar vestibular, avoiding interference with Precision Wings. Currently, in the prescription form there is the option of prescribing Class II short elastics on the vestibular face of teeth adjacent to the Precision Wings, for cases in which it is considered that the use of this type of elastics may be beneficial.



Treatment plan

- 01 **Pre-advance phase:** Elimination of transversal interferences and levelling of the lower Spee curvature by intrusion of lower incisors and extrusion of premolars in order to eliminate possible interferences of the lower incisors with the upper incisors during the advancement phase.
- 02 **Advance phase:** This phase is mainly oriented to the objective of mandibular advancement, and allows dental alignment simultaneously with mandibular advancement. In order to keep the mandibular position stable at night, the use of class II intermaxillary elastics for night use was prescribed.

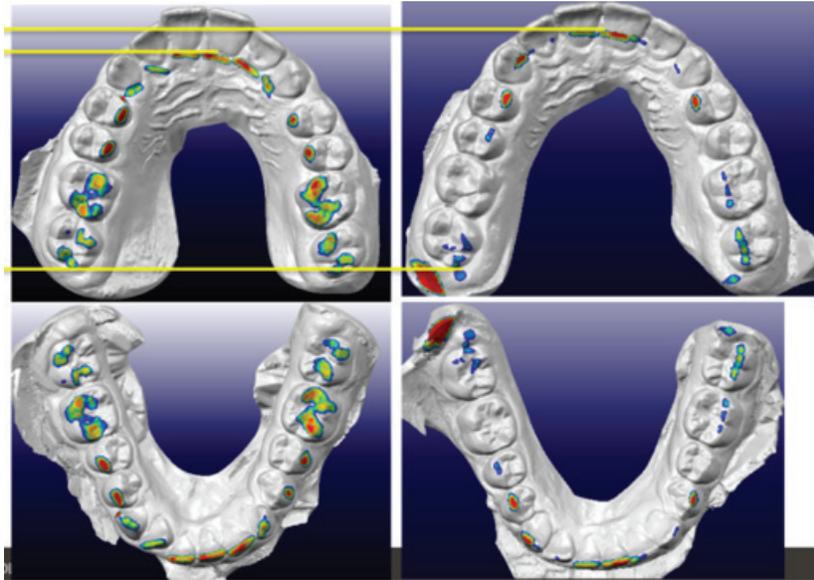
To avoid interferences between the intermaxillary elastics and the Precision Wings, the use of elastics was planned from palatine of superior canines to vestibular of second molars, the elastics used were 5/16" of 6 ounces, the sagittal effect of the elastics maintains *Precision Wings* well positioned during the night, thus keeping the jaw in a position of symmetrical advance during all hours of sleep.

Currently, in the prescription form there is the option of prescribing Class II short elastics on the vestibular face of teeth adjacent mesial to the Precision Wings, for cases in which it is considered that the use of this type of elastics may be beneficial.

- 03 **Transition phase:** The objective of this phase is to maintain the position reached in the mandibular advancement phase until the start of the Additional Aligners.
- 04 **Additional Aligners Phase:** At this stage our aim was the subsequent settling of the occlusion. Triangular elastics were used as an auxiliary technique for the optimization of the posterior occlusion settling. We ask the patient to keep class II elastics at night to prevent class II recurrence.

Evolution records

Advance measured with iTero Element before Additional Aligners.



Pictures of evolution 11 months after starting treatment, before Additional Aligners



Final records

Final front side



Final profile



Final smile



Final right lateral



Final intraoral front



Final left lateral

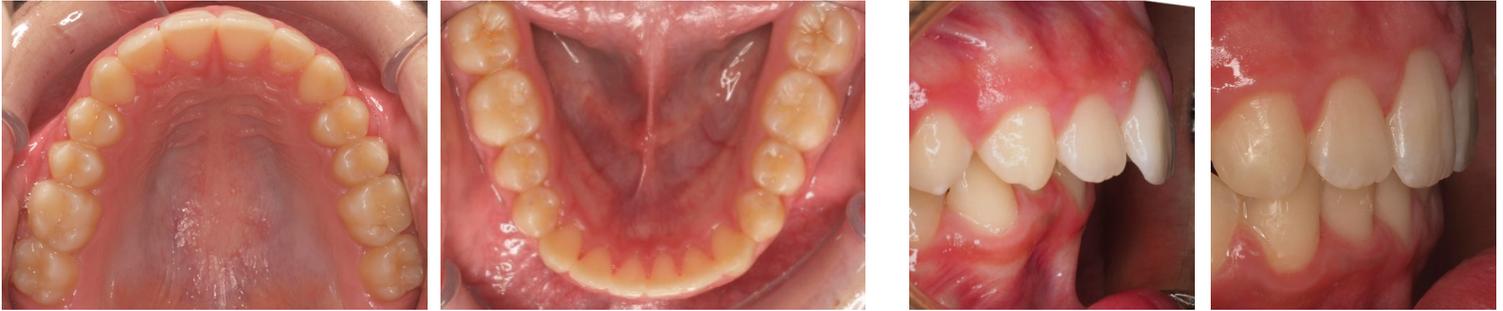


Final upper occlusal

Final lower occlusal

Initial highlight

Final highlight



Final cephalometric values



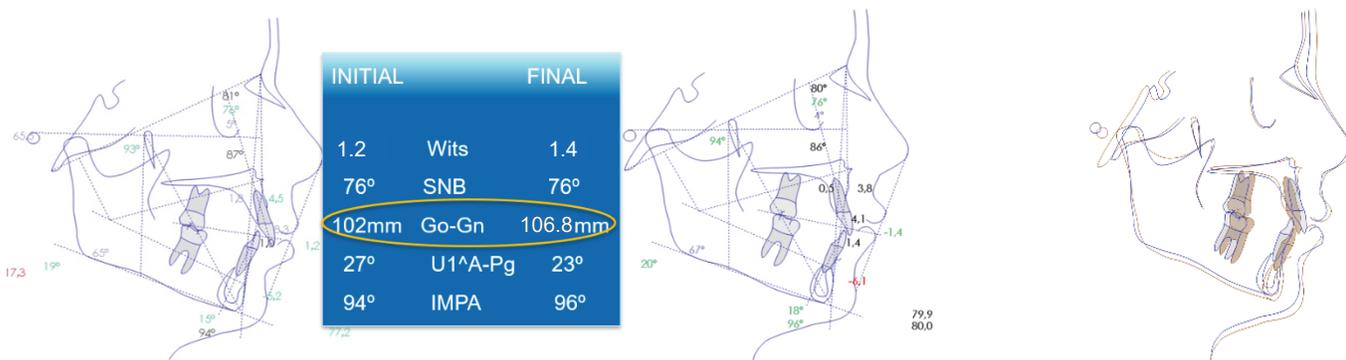
Key cephalometric values

Measurement (degrees)	Initial	Standard	Dev. Typ.
SNA	80	80	2.0
SNB	76	82	2.0
ANB	4	2.0	1.5
U1-SN	95	103	6.0
L1-GoGn	96	93	3.0
Interincisal	139	135	6.0
Sn-GoGn	29	32	4.0

Cephalometric changes experienced

- Mandibular length and Gonion Gnathion distance increased by 4.8 mm
- Jaw rotated counterclockwise
- The upper incisor was retroclined and we obtained a good control of the lower incisor, which was vestibulized only 2° during treatment.
- No changes were observed in the angle of the mandibular plane

Cephalometric overlap



Treatment Overview

Total treatment time 18 months. Weekly change of aligners.

- **Pre-advance phase:** 12 upper and lower aligners
- **Mandibular advance phase:** 32 upper and lower aligners
- **Transition phase:** 4 aligners
- **Additional Aligners:** 28 upper and lower aligners
- **Retention:** Vivera retainers for night use

Discussion of results

The results in skeletal correction were equivalent in the two clinical cases included in this study, thus showing similar clinical efficacy for both advancement devices (Herbst, Invisalign System with mandibular advancement).

The following table summarizes the comparison between clinical case #1 (conventional 2x4 appliance, Herbst, followed by Invisalign Lite) and clinical case #2 (treated with Invisalign System with mandibular advancement).

	Clinical Case #1 Patient treated with Herbst followed by Invisalign Lite	Clinical Case #2 Patient treated with Invisalign with mandibular advancement, MA
N°Orthodontic devices used	3	1
Treatment time	33 Months	18 months
Skeletal correction (Go-Gn)	5 mm	4.8 mm
Vestibulum-version of the lower incisor	from 2° to 5°	< 2°
Side open bite (Gap)	> 3 mm	< 3 mm
Wearing time class II elastics (nocturnal)	14 months	11 months

Discussion of results

- 01 Invisalign treatment allows levelling of the curve of **Spee** during the pre-advancement phase, which reduces the possibility of developing posterior open bite during mandibular advancement.
- 02 The Invisalign treatment makes it possible to perform a **gradual advancement of the jaw**. With the Herbst device the patient experienced from the start of treatment a forced position of mandibular advancement, that was very uncomfortable in the first moments and did not improve until months later as the protrusion was reduced, however with the mandibular advance device of the Invisalign System, the jaw is taken to a gradually advanced position of 2 mm every 8 aligners, which allows us to improve the comfort and aesthetics of the patient with the use of the device from the beginning of treatment, significantly improving the collaboration by the adolescent patient.
- 03 Invisalign treatment allows **dental alignment simultaneously with mandibular advancement**. With a single device, we achieved orthopedic and dental correction of the patient while reducing the total treatment time.

Use of elastics. In the case treated with the Invisalign System with mandibular advancement, class II elastics only had to be used at night both during the mandibular advancement phase and during the first three months of the Additional Aligners phase. The nocturnal elastic protocol was 5/16" 6 ounces.

The use of the elastics placed from palatine of upper canines to vestibular of lower second molars (5/16"), did not interfere with the operation of the Precision Wings helping to prevent their distortion and the possible asymmetric advance of the mandible.

Currently, in the prescription form there is the option of prescribing Class II short elastics on the vestibular face of teeth adjacent mesial to the Precision Wings, for cases in which it is considered that the use of this type of elastics may be beneficial.

Clinical recommendations on the use of the mandibular advancement function of the Invisalign system

- It is imperative before starting the mandibular advancement phase to make sure to correct any posterior crossbite or transverse interference, to level the lower Spee curvature to avoid previous interferences and to provide sufficient protrusion to allow correction of the molar and canine class during the advancement phase.
- During the mandibular advancement phase the molars must reach a superclass I position.
- During the diagnostic phase of the patient, guiding the mandible to a mandibular advance position will allow us to detect interferences in the transverse and sagittal plane that we have to correct prior to the onset of mandibular advance.
- The elimination of anterior and transversal interferences during the pre-advance phase allows us to reduce the lateral open bite that appears during the advancement phase, improving patient comfort.

Recommendations for the selection of cases to be treated with the Invisalign System with mandibular advancement

When you begin to use this function, the most favourable cases, as the bibliography indicates in terms of functional devices, are:

- Patients with class II first division with mandibular hypoplasia
- Moderate prominence less than 7 mm
- Horizontal growth pattern
- In pubertal acceleration phase CS3/CS4
- In full permanent dentition

As more mastery of the use of Invisalign with mandibular advancement is acquired, the clinician could begin with this treatment in patients with:

- Classes II second division with little prominence at the beginning of the treatment
- Hyperdivergent patterns
- Class II in stable mixed dentition with short clinical crowns.

Conclusions

- 01 Invisalign treatment with mandibular advancement has the same efficacy as the Herbst mandibular advancement device, but allowing simultaneous dental alignment, providing an aesthetic and comfort to the patient superior to that observed in adolescents who used removable functional devices. The correction, when performed with only one device and simultaneously create mandibular advancement and align the dentition, allows us to considerably reduce the patient's overall treatment time.
- 02 In the case of the patient treated with the Invisalign System with mandibular advancement included in this study, class II elastics, limited to nocturnal use, it helped to maintain the advanced position of the mandible during the night and to prevent the distortion of the Precision Wings. They also contributed to the collaboration on the part of the adolescent patient since they helped the patient to find a mandibular advancement position in a simpler and more stable manner.
- 03 Posterior open bite seen in patients treated with removable functional devices, similar to the patient included in this study treated with Herbst, is considerably reduced in patients in Invisalign treatment with mandibular advancement, as the Spee curvature levelling that we perform in the pre-advance phase and the crown-vestibular torque applied to the upper incisors allows us to decrease the previous prematurities at the time we started the advancement phase, also achieving a good control of the final torque of the lower incisors since the Invisalign clear aligners with mandibular advancement feature covers the vestibular face of the mandible at all times.

Lessons learned from Invisalign treatment with mandibular advancement

- 01 The Spee curvature levelling in the pre-advance phase and the elimination of transverse interferences are essential to avoid prematurity during the advancement phase and the generation of a posterior open bite.
- 02 The use of class II elastics for night use in this patient helped to maintain the advanced position of the jaw at night and to prevent distortion of the Precision Wings.

The use of elastics may be especially beneficial in patients with excessive protrusion at the beginning of treatment or in those in whom progress is made in a single jump. In these cases, the use of class II elastics together with Precision Wings helps the patient to find a mandibular advancement position in a simpler and more stable manner and ensures symmetrical advancement of the mandible.

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