Non-Surgical Clinical Protocol for the Treatment of a Class II Malocclusion in an Adult

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ABSTRACT
A 38-year-old man with a skeletal Class II division 2 malocclusion, whose chief complaints were the unaesthetic appearance and the retruded chin, showed an incompetence for proper function in the anterior region, due to the deep overbite, as observed at clinical examination. He also had a both transversally underdeveloped lower and upper arch, and the absence of teeth 18 and 27. The treatment underwent nonsurgical rapid maxillary expansion with McNamara bonded Haas, and with a Twin-Force, a fixed appliance for correcting sagittal Class II malocclusion, whose purpose is mandibular anterior repositioning, allowed the non-surgical correction of this malocclusion. The aim of this study is to evaluate the effects of this treatment regarding: the profile, occlusion, dental-skeletal harmony of the patient, in the resolution of a case of skeletal Class II division 2 malocclusion using a Twin Force appliance in an adult. This approach has shown to have a highly acceptable treatment outcome, by correcting the transversal and sagittal problems, and reaching a stable and functional occlusion.

Keywords: Mandibular Propulsion, Class II, Functional Appliances

Introduction
Dental class II relationship is determined according to the position of the first molars and was first classified by Angle (1899) who chose the upper first permanent molar as the “key” to occlusion and to his classification; the variable factor was the anteroposterior position of the lower first molar in its occlusal relation to the upper molar. In an Angle Class II, a distal relation of the lower arch, when related to the upper arch, is present; the lower first permanent molar is locking more than one-half of a cusp distal to normal relation with the upper first permanent molar [1]. This Class is divided into division 1, where the upper incisors are protruded and division 2, where the axis of the upper incisors are retruded [3,2].

Class II malocclusion is the most frequent sagittal problem in orthodontics, as it affects one third of the population [4,5]. Although maxillary protrusion and mandibular retrognathism are both found to be possible causal factors, McNamara reported that mandibular retrognathism is more common for skeletal Class II malocclusion [5]. There are various treatment methods, like advancing the mandible by functional appliances, extra oral appliances, camouflage treatment and surgical repositioning of the jaws for the correction of skeletal class II malocclusions [6].

Orthognathic surgery is considered for the treatment of dentofacial skeletal deformities for more than 100 years ago. Interestingly, the first jaw deformity correction was performed without anesthesia in the United States by Simon Hullihen, an American general surgeon, in the mid of the 19th century. However, in our orthodontic practice we have seen a recent spurt of increasing numbers of young adults who desire cost effective, non surgical correction of Class II malocclusion and accept dentoalveolar propulsion, for some considered as dental camouflage as a treatment option to mask the skeletal discrepancy.

Corrections of the Class II dental arch relationship and overjet are mainly accomplished by anterior advancement of the mandible (stimulation of condylar growth), distal movement of the maxillary lateral teeth, and proclination of the mandibular incisors. Overbite reduction results from extrusion of the mandibular molars and intrusion of the mandibular incisors [7]. One of the recommended therapeutic approaches to Class II malocclusion in growing patients is functional jaw orthopedics through the primary mechanism of mandibular advancement [4,8,9]. This treatment is controversial in adult patients, but some authors believe that this patients can also be successfully treated without surgery [3].

Fixed devices for sagittal advancement of the mandible that do not require the patient’s collaboration and that can be worn in association with fixed appliances have been introduced to the orthodontic community in order to overcome two major limitations of removable functional appliances: the need for...
patient collaboration and the lack of the possibility of combining the use of the functional appliance with multibracket therapy in order to shorten treatment duration [4,10]. The effects of several compliance-free appliances for mandibular anterior repositioning in association with fixed appliances have been investigated in the literature [4,11].

One fixed appliance for correcting Class II malocclusion is the Twin Force. The Twin Force is a fixed, push-type intermaxillary functional appliance with balland-socket joint fasteners that allow a wide range of motion and lateral jaw movement [12].

The aim of this study is to evaluate the effects of the proposed treatment regarding: the profile, occlusion and dental-skeletal harmony of the patient, in the resolution of a case of skeletal Class II malocclusion using a Twin Force in an adult.

Clinical Case
Diagnosis and Etiology
The patient JPP was a 38 years 4 months-old man, who had as chief complaints the unaesthetic appearance, the retruded mandible, and who showed an incompetence for proper function in the anterior region, due to the deep overbite, observed at clinical examination. The patient asked for non-surgical orthodontic treatment.

His facial profile was concave, with a long anterior facial height, and a skeletal Class II malocclusion. He showed no allergies or significant finding in his medical history. None of the patient’s direct family members had skeletal Class II.

From the dental perspective, full complement of permanent teeth was present (except upper right third molar, and upper left second molar). The patient already had an implant for the rehabilitation of the tooth 27. (Figures 1 and 2). Both canine and molar relationships were Class II, at the both sides, and a deep overbite was present. Both the maxillary and the mandibular arches exhibited, transversally, arch length discrepancies, being the maxillary severe and the mandibular mild with mild crowding. Oral hygiene was good.

Figures 1 and 2: Pretreatment panoramic and lateral cephalometric radiography

Table 1: Cephalometric Summary

<table>
<thead>
<tr>
<th>Cephalometric Measurements</th>
<th>Norm</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frankfurt Horizontal ┴N A (mm)</td>
<td>0-2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Co A (mm)</td>
<td>94</td>
<td>94</td>
<td>91</td>
</tr>
<tr>
<td>Co Gn (mm)</td>
<td>121-124</td>
<td>114</td>
<td>115</td>
</tr>
<tr>
<td>AFAI (mm)</td>
<td>66-67</td>
<td>67</td>
<td>69</td>
</tr>
<tr>
<td>Rickets (°)</td>
<td>90°</td>
<td>89°</td>
<td>90°</td>
</tr>
<tr>
<td>MM (°)</td>
<td>28°</td>
<td>22°</td>
<td>22°</td>
</tr>
<tr>
<td>FMA (FH MP) SNA SNB ANB SN-GoMe Po-PMAX Po-MeGo Overbite (mm) Ovejet (mm)</td>
<td>26° 82° 80° 2° 32° 11° 14°</td>
<td>22° 90° 82° 8° 27° 4° 18° 30° 11° 11°</td>
<td></td>
</tr>
<tr>
<td>U1-SN plane</td>
<td>103°</td>
<td>103°</td>
<td>106°</td>
</tr>
<tr>
<td>IMPA</td>
<td>95°</td>
<td>99°</td>
<td>106°</td>
</tr>
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Obviously no growth is to be expected in male patients of this age, nevertheless the appraisal of a patient’s skeletal maturity has always been considered a key factor for the application of the concept of treatment timing to clinical practice. The biological indicator of skeletal maturity that has been used in this case was the cervical vertebral maturation (CVM) [13].

**Figure 3: Patient’s Cervical Stage**

After completing the collection and the analysis of complementary diagnostic exams (intra and extraoral photographs, radiographs and dental cast models), the patient was diagnosed with a Class II malocclusion. Cephalometric analysis indicated a retrognathic mandible, accompanied by facial, dental and skeletal changes intrinsic to this type of malocclusion. The facial pattern of the patient was brachyfacial. The cephalometric analysis also shown a palatal inclination of the upper incisors, which is a characteristic of this malocclusion. (Table 1).

**Figure 4: Pretreatment facial and intraoral photographs**

**Treatment Objectives**
The treatment objectives were to solve the maxilla and mandible transversal underdevelopment, the mandibular retrognathism, the pronounced overjet and deep overbite that the patient presented, and achieve a functional and normal occlusion bilateral Class I with a functional mandibular cinematics.
Treatment Alternatives
Two treatment alternatives were presented to this nongrowing patient:

1. A combined orthodontic and surgical treatment with orthognathic surgery to reposition the mandible and the maxilla. Skeletal Class II problems are due to mandibular deficiency or downward backward rotation of the mandible caused by excessive vertical growth of the maxilla. Surgical treatment, therefore, consists of mandibular advancement, superior repositioning of the maxilla, or a combination. The principal disadvantage was the patient himself, which was determined to avoid the associated surgical risks and complications, as well as the increased expense.

2. In a non-extraction treatment, crowding can be solved by expansion of the arches and proclination of upper and lower incisors. This would improve the dental esthetics, the correction of deep overbite would be easier, and it would allow the necessary overjet for the mandibular advancement. So, we suggest a bonded rapid maxillary expansion device, such as the modified Haas, provided with neutral pads, that allows it to function as a splint, accordingly to the Handelman’s Protocol, once the evidence suggests that most adult patients requiring maxillary transarch expansion can be successfully treated without surgery [14]. Additionally, to improve the sagittal occlusion and the patient’s profile, a fixed appliance, the Twin Force device, would be used to provide mandibular propulsion.

After explaining the treatment alternatives to the patient, the last option was selected, with the patient’s written consent.

Treatment Plan
The proposed treatment plan for this patient was a McNamara bonded Haas for maxillary expansion, followed by a transpalatal and lingual arches for anchorage, a fixed appliance to extrude the mandibular posterior teeth and resolve the deep overbite along with a Twin Force for mandibular advancement.

The treatment plan was presented and discussed with the patient, who authorized the execution of the clinical procedures.

Treatment Progress
All general dental treatments were performed before starting the process. The treatment began with the application of McNamara bonded Haas [15].

The device adopted by us is based on the prototype announced by Haas and McNamara with an alveolar-dental-supported anchorage [16,17]. In this device, the acrylic covers the entire vestibular surface of the teeth involved; in the palatal surface it covers half of this, leaving one free interface between the palatine mucosa, and the hyrax screw, which allows a better hygiene, maintaining the necessary anchorage without extending across the palatal suture region. This acrylic coating allows a more uniform expansion, and mandibular deprogramming, eliminating any dental interference. Its extension to buccal and palatal decreases the effect of tipping characteristic of other devices of expansion [18-20].

The degree of activation recommended was ¼ turn, every other day, to allow a light and smooth expansion. Activation of the expansion screw at the rate appropriate for children will cause unacceptable palate swelling and pain in adults [14] This procedure was performed for 3 months until achieving the desired maxillary expansion, following the guides provided by the Handelman’s Protocol [14].

After maxillary expansion, the McNamara bonded Haas was removed and proceeded to cementing the transpalatal archwire, in order to avoid transversal relapse. It was also cemented a lingual arch to provide teeth anchorage prior to the propulsion device, for the following purposes: to increase the mass effect of mandibular protrusion and avoid the side effects of this movement, as the retrusion of the maxillary incisors and protrusion of the mandibular incisors.

Then, the conventional fixed appliances were cemented in both arches, using MBT prescription, and a 0.22 slot, proceeding the arch sequence until it was necessary to adapt a 0.019x0.025 stainless steel posted arch wire. The MBT prescription was introduced by McLaughling, Bennet, and Trevisi in 1998. The increased palatal root torque in the upper incisors improves upon the undertorqued appearance produced by other prescriptions and the increased labial root torque in the lower incisor counteracts the forward tipping during leveling [21,22].

After reaching well-aligned arches, the Twin Force was placed to start the mandibular propulsion. Twin force is a fixed, push-type inter-maxillary functional appliance with ball-and-socket joint fasteners that allow a wide range of motion and lateral jaw movement [23,24]. The two plunger/tube telescopic assemblies on each side contain nickel titanium coil springs that deliver a constant force. Measuring several appliances with a force gauge demonstrated an average full-compression force of approximately 210g [12,24]. The appliance is attached to the maxillary and mandibular arch wires by hex nuts fastened mesial to the maxillary first molars and distal to the mandibular canines. At full compression, the Twin Force postures the patient’s mandible forward into an edge-to-edge occlusion [12,23].

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Figure 5: Intraoral photograph of the Twin Force appliance frontal and lateral views

Functional appliances are often the preferred modality of treatment in patients with growth potential. These include a variety of removable or fixed appliances designed to alter the mandibular position sagitally and vertically, resulting in orthodontic and/or orthopedic changes [25]. Of all appliances, fixed functional appliances (FFAs) are gaining popularity...
because compliance may be better than removable appliances [26]. Class II correction with a FFA is a combination of skeletal and dentoalveolar changes, which include restraining maxillary growth, dubbed as the “headgear effect,” retroclination of maxillary and proclination of mandibular incisors, distalization of upper and mesial movement of lower molars, along with clockwise rotation of the occlusal plane [4,23,27-30].

Charlier et al, and some other authors, have demonstrated that appliances that place the mandible anteriorly stimulate significant mandibular growth by condyle remodeling in animal models, but the effects produced in humans, in their studies, were not the same [31-34]. Evidence shows that favorable growth responses are not always achieved with functional therapy; some authors reported increases in overall mandibular length and changes in the amount of condylar growth, but others believe that mandibular length cannot be altered by such therapy. It has been claimed that most of the correction of the malocclusion is due to dentoalveolar changes with a small but statistically significant amount of skeletal effects [35-49].

Inter maxillary short elastics were also used for Class II during the final stages of the treatment and class I at the final phase for detailing and finishing. Patient compliance in using the elastics was as expected throughout the treatment.

The total treatment time was approximately 36 months. The retainers were the thermoplastic type and used full time, except during meals and brushing, for the first 12 months. After this period, the retainers were switched to nocturnal use only for another 12 months.

**Figure 6:** Posttreatment facial and intraoral photographs
Treatment Results

All treatment objectives were achieved. The transverse maxillary and mandibular arch deficiency was corrected as well as the retruded mandibular position, satisfactory dental alignment, normal overjet and overbite, and ideal Class I molar and canine relationships on both sides were established (Figure 7 and 8). Finally, it was observed that the results were mainly dentoalveolar.

The overall facial balance was greatly improved. The post treatment extraoral photographs showed an improved profile, a facial symmetry and a favorable smile arc. However it will be necessary an interdisciplinary treatment consisting in a rehabilitation of the anterior teeth to provide an esthetically pleasing smile, and a prosthetic rehabilitation of the 27 and 17.

The patient was extremely satisfied with his teeth, smile and profile.

In the panoramic radiograph, root parallelism was good, and no apical resorption was observed (Figure 8). The cephalometric findings of the treatment are shown in Table 1. ANB was decreased (from 8° to 7°) because of the slight retrusion of maxilla and protrusion of the mandible (SNA decreased from 90° to 87°). This results are as expected according to Everdi and Arvysts studies; Arvysts presented two cases of nonextraction treatment of severe Class II division 2 malocclusion; at the end of the treatment, he noticed that the SNA angle was reduced. He explained this minor change as an effect of the maxillary incisor root torque, accordingly to Erverdi that reported that there is a significant correlation between the axial inclination of the upper incisors and the position of point A [50-53].

The effective maxillary length (Co-A) decreased from 94 to 91, because of the changes in the superior incisors torque, once the position of point A, is believed to be affected by alveolar bone remodeling associated with orthodontic tooth movement of the upper incisors.53 Significant posterior rotation of the mandible elongated the anterior facial height, which can be seen in the AFAI measures of the pretreatment an posttreatment cephalometric analysis (AFAI increased from 67 to 69mm).

Discussion

The treatment of Class II, division 2, malocclusion has always been a challenge for orthodontists. This is because in most cases, this malocclusion is accompanied by an horizontal growth pattern, an anterior deep overbite and a decrease of the anterior facial height [54].

In adult severe cases, the combined approach, orthodontic and orthognathic surgery, is believed to be the treatment of choice, and the results obtained usually ensure a proper esthetic, functional, and stable results.

However, we sometimes treat patients with severe problems who do not want surgery as a part of their treatment plans.

The concept that nonsurgical maxillary expansion can be successful in adults has raised questions in the literature [55-58]. Overall, the consensus is that, once patients are out of their teens, that type of expansion is no longer feasible, and instead, surgically assisted rapid maxillary expansion is necessary.

However, the evidenced-based literature demonstrates that adult patients requiring maxillary transarch expansion can be successfully treated without surgery [14,59-64]. Therefore, the expansion was made accordingly to the Handelman’s Protocol [14]. In view of the costs, morbidity, and surgical risks of surgically assisted rapid maxillary expansion, patients should be informed of the nonsurgical option before they are asked to consent to either mode of treatment [59-64].

The dentoalveolar maxillary expansion was essential for the establishment of a balanced occlusion [14,65]. In this case, our results are according to the authors who claim that nonsurgical maxillary expansion in adults is possible and a viable solution.

As Regards to Mandibular Propulsion

Combined surgical-orthodontic treatment can be carried out successfully for patients with severe dentofacial problems of any type. Maxillary surgery is tolerated better than mandibular bilateral sagittal split osteotomies. Often psychological evaluation of the patient before the surgery is mandatory, and carefully preparing the patient for their surgical experience would benefit the patient to adapt to the significant facial changes.

Several cases have been presented, where adult patients with severe Class II malocclusions have undergone orthodontic treatment combined with mandibular osteogenic distraction, instead of conventional bilateral sagittal split osteotomies.
Osteogenic distraction is a technique for gradually lengthening bone by the application of a gradual external force over a corticotomy site. The concept was first published by Codivilla in 1905, but was pioneered by Ilizarov (1988), and has been used for many years by orthopaedic surgeons. Recently, it has been developed for correction of craniofacial anomalies.

However, in our orthodontic practice we have seen a recent spurt of increasing numbers of adults who desire cost effective, non-surgical correction of Class II malocclusion and accept dentoalveolar propulsion, in order to mask the skeletal discrepancy. Regarding to functional therapy, an increasing general consensus reports increases in overall mandibular length and changes in the amount of condylar growth, but others believe that mandibular length cannot be altered by such therapy. It has been claimed that most of the correction of the malocclusion is due to dentoalveolar changes with a small but statistically significant amount of skeletal effects [53]. Our results demonstrated that the changes were due to dentoalveolar remodeling, more than skeletal growing, as expected in an adult patient.

The treatment plan consisted in maxillary expansion, achieved by a bonded Haas, bimaxillary fixed appliance, TPA and Lingual Arch for maxillary and mandibular anchoring, and finally, Twin Force for mandibular propulsion.

The primary contributing factor responsible for a Class II malocclusion is a deficient mandible, due to either reduced ramus height or reduced mandibular length [66-68].

The theoretical prediction of the forces and moments produced by the TFBC appliance is shown in Figure 9. The mechanics of a FFA suggests a tendency towards canting the occlusal plane due to the moments being generated. As seen in our treatment results, the occlusal plane was canted, with an increase in the Po-Pmax (4º to 11º) and a decrease in the Po-MeGo (18º to 11º).

Figure 9: The theoretical prediction of the forces and moments

As for dentoalveolar effects, the upper incisors were distalized under the “headgear effect” of the FFA, while the lower molars moved mesially [15,17,53]. There is some controversy concerning the upper molars dentoalveolar effects, on the biomechanical model (Figure 9) there is a distal and intrusive force on the upper molars, but different observations state otherwise, that they suffer an extrusion and mesial movement.

Mesialization and extrusion of the upper molars after use of the FFA has been reported.4;71-75 This may be attributed to the mechanics involved during finishing of treatment after removal of the FFA or natural tendency of teeth to drift mesially and occlusally [23,35].

Regarding this issue our results are consonant with the biomechanical model and in disagreement with the reports that oppose it. In the panoramic radiography analyzes shown in Figure 10 it’s clear the distal movement of the 26 towards the implant in the 27 region and in the first quadrant the distal movement of first and second maxillary molars towards the tuberosity. Furthermore the distance between the apex of the mesial root of the first molar and the maxillary plane has decreased.

The particularity of having an implant placed previous the orthodontic treatment allows us to have a clear image of the sagittal and vertical changes that the molars underwent.

Figure 10: The position change of upper left first molar regarding the implant pre and post treatment

Class II malocclusions resulting from mandibular retrusion are generally treated with functional orthodontic appliances that create orthopedic forces directed at the mandibular structures. These orthodontic appliances influence the jaws via the following mechanisms: remodeling of the mandibular condyle, remodeling of the glenoid fossa, repositioning the mandibular condyle in the glenoid fossa, and autorotation of the mandibular bone. [76,77].

Accordingly to the study of Seniz et al, when we found a decrease at the SNA angle, it means that the appliances were effective in restraining the forward growth of the maxilla, which should not be applied in our case, despite the decrease of SNA (90º to 87º), once the changes were not due to the effect in growth, but due to an “en masse” distalization of the maxilla, and to the effect in the point A, which is dentoalveolar variable, caused by the torque change in of the central incisor. It is a known fact that point A is influenced by the dentition. When the upper incisors are retruded, labial tipping of the roots can shift the point A anteriorly.78 .Regarding to point A, in our case it wasn’t observed this anterior shift, having been verified a decrease in the Co-A measure (94 mm to 91mm).

Conclusion

The correction of class II malocclusion can be undertaken in a variety of ways, e.g. advancing the mandible by functional appliances, extra oral appliances, camouflage treatment and surgical repositioning of the jaws for the correction of skeletal class II malocclusions.
The treatment plan performed for this patient was a McNamara bonded Haas, transpalatine and lingual arches for anchorage, conventional fixed appliance and a Twin Force for mandibular advancement. This approach has shown to have an excellent treatment outcome, achieving the proposed goals and leaving the patient extremely satisfied with his teeth, smile and profile.

The total treatment outcome of this Class II with deep overbite using these biomechanics was satisfactory, both intraorally (occlusal and functionally) and extraorally (esthetics).

However, we recommend the esthetic rehabilitation of the anterior teeth, due to the excessive pigmentation and poor composite restorations, and prosthetic rehabilitation of the upper second molars, which should be done posteriorly.

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