ASK Publishers

ISSN: 3033-3555

Case Report

Journal of Stomatology & Dental Research

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

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Received: May 20, 2023; **Accepted:** June 12, 2023; **Published:** June 16, 2023

ABSTRACT
A 38-year-old man with a skeletal Class II division 2 malocclusion, whose chief complaints where 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 the 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 have 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 rela tion 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 sur gical 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 cor rection 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 considere 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 ther apeutic 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

Citation: Paulo Fernandes Retto. Non-Surgical Clinical Protocol for the Treatment of a Class II Malocclusion in an Adult. J Stoma Dent Res. 2023. 1(1): 1-10. DOI: doi.org/10.61440/JSDR.2023.v1.02

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.

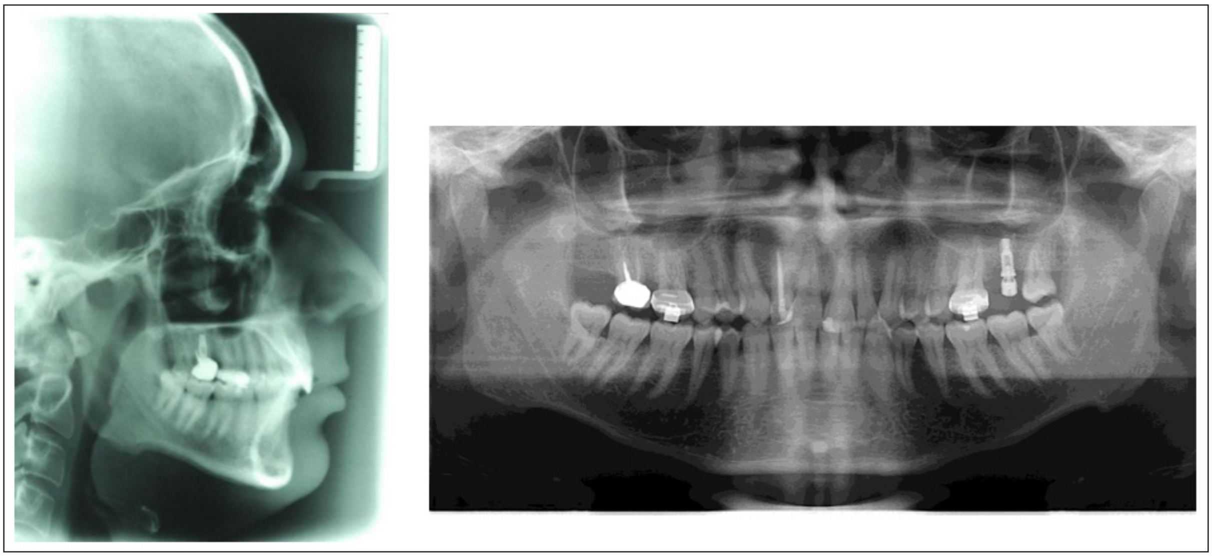
Clinical Case

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

Cephalometric Measurements	Norm	Pretreatment	Posttreatment
Frankfurt Horizontal ┴N A (mm)	0-2	3	1
Co A (mm)	94	94	91
Co Gn (mm)	121-124	114	115
AFAI (mm)	66-67	67	69
Rickets (º)	90º	89º	90º
MM (º)	28º	22º	22º
FMA (FH MP) SNA SNB ANB SN-GoMe Po-PMAX Po-MeGo Overbite (mm) Ovejet (mm)	26º 82º 80º 2º 32º 11º 14º	22º 90º 82º 8º 27º 4º 18º	27º 87º 80º 7º 30º 11º 11º
U1-SN plane	103º	103º	106º
IMPA	95º	99º	106º

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].

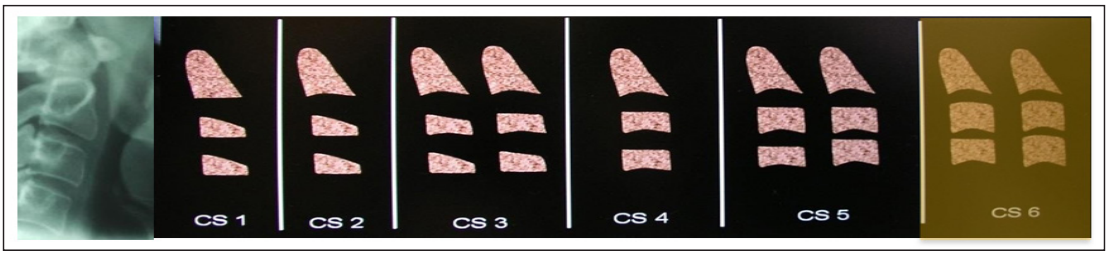


Figure 3: Patient´s Cervical Stage

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 possible 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].

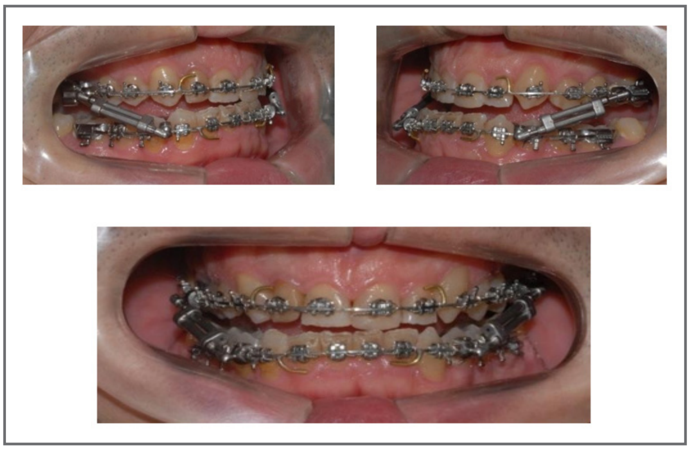


Figure 5: Intraoral photograph of the Twin Force appliance frontal and lateral views

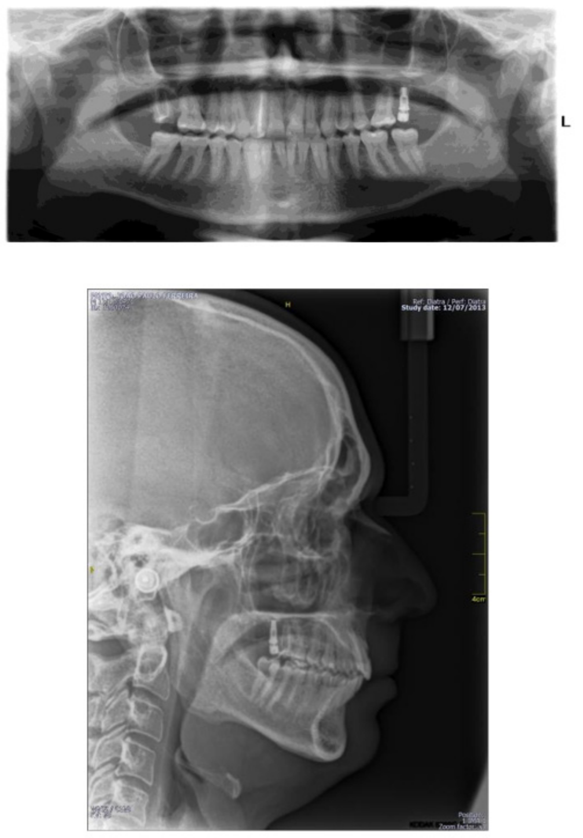
Functional appliances are often the preferred modality of treatment in patients with growth potential. These include a variety of removable or fixed appliances designed to alter the mandibular position sagittally and vertically, resulting in orthodontic and/or orthopedic changes [25]. Of all appliances, 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: Postreatment facial and intraoral photographs



Figures 7, 8: Postreatment panoramic and lateral cephalometric radiography

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 8º to 7º) because of the slight retrusion of maxilla and protrusion of the mandible (SNA decreased from 90º to 87º). 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 postreatment 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 coritcotomized 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).

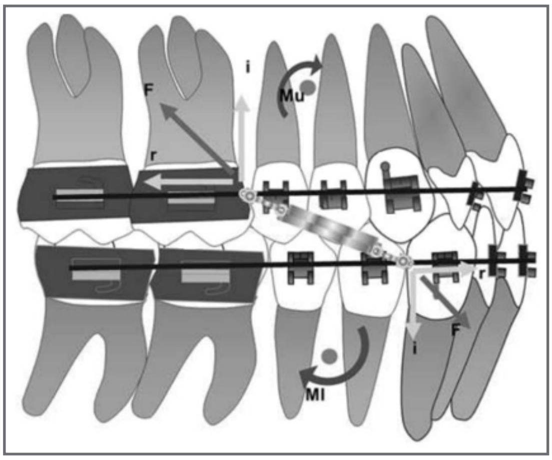


Figure 9: The theoretical prediction of the forces and moments

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.

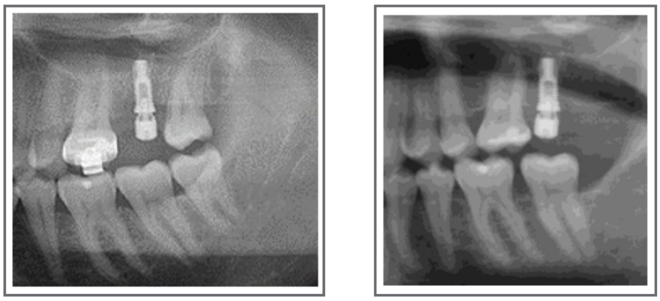


Figure 10: The position change of upper left first molar regarding the implant pre and post treatment

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 dentoalveollary 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 have 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.

References

1. Blair E. A Cephalometric Roentgenographic Appraisal of the skeletal Morphology of Class I, Class II, DIV. 1, and Class II, Div. 2 (Angle) Malocclusions; the Angle Orthodontist. 1954. 24: 106-119.
2. Henriques RP. Efeitos Dentoesqueléticos do aparelho de protação mandibular (APM) no tratamento da má oclusão de classe II divisão 1. Revista Faipe. 2011. 1: 1
3. Bicalho J, Bicalho R. Utilização do APM no tratamento da má oclusão de Classe II, 2a divisão, em paciente adulto; Dental Press, Maringá. 2007. 6.
4. Franchi L, Alvetrob L, Giuntinic V, Masuccid C, Defraiae E, et al. Effectiveness of comprehensive fixed appliance treatment used with the Forsus Fatigue Resistant Device in Class II patients; Angle Orthodontist. 2011. 81: 4.
5. Cozza P, Baccetti T, Franchi L, Toffol L, McNamara J Jr. Mandibular changes produced by functional appliances in Class II malocclusion: A systematic review; Am J Orthod Dentofacial Orthop. 2006. 129: 599.
6. Gupta P, Aghera M, Nagar N, Kambalyal P. Management of skeletal class II malocclusion with twin block and fixed appliance therapy in an 11 year old girl; J Res Adv Dent. 2014. 3: 149-156.
7. Hans Pancherz, Krister Bjerklin, Birgitta Lindskog-Stokland, Ken Hansend. Thirty-twoyear follow-up study of Herbst therapy: A biometric dental cast analysis; Am J Orthod Dentofacial Orthop. 2014. 145: 15-27.
8. Cacciatore G, Alvetro L, Defraia E, Huanc Ghislanzonid L, Franchi L. Active-treatment effects of the Forsus fatigue resistant device during comprehensive Class II correction in growing patients; Korean J Orthod. 2014. 44: 136-142.
9. McNamara JA Jr, Brudon WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, Mich: Needham Press Inc. 2001. 2001: 73.
10. Tulloch JF, Proffit WR, Phillips C. Outcomes in a 2-phase randomized clinical trial of early Class II treatment.; Am J Orthod Dentofacial Orthop. 2004. 125: 657-667.
11. Stromeyer EL, Caruso JM, DeVincenzo JP. A cephalometric study of the Class II correction effects of the Eureka Spring. Angle Orthod. 2002. 72: 203-210.
12. Rothenberg J, Campbell E, Nanda R. Class II Correction with the Twin Force Bite Corrector, JCO. 2004. 232-240.
13. Franchi L, Baccetti T, De Toffol L, Polimeni A, Cozza P. Phases of the dentition for the assessment of skeletal maturity: a diagnostic performance study. Am J Orthod Dentofacial Orthop. 2008. 133: 395-400.
14. Handelman C. Palatal expansion in adults: The nonsurgical approach. AJO-DO; October. 2001. 140: 463-468.
15. Filho L, Filho O. Expansão Rápida da Maxila: Considerações Gerais e Aplicação Clínica. Parte I Revista Dental Press de ortodontia e ortopedia maxilar. 1997. 2.
16. McNamara JA Jr. An orthopedic approach to the treatment of Class III malocclusion in young patients. J Clin Orthod. 1987. 21: 598-608.
17. Haas A. Rapid Expansion Of The Maxillary Dental Arch And Nasal Cavity By Opening The Midpalatal Suture. The Angle Orthodontist. 1961. 31: 73-90.
18. Asanza S, Cisneros G, Nieberg L. Comparison of Hyrax and bonded expansion appliances. The Angle Orthodontist. 1997. 67: 15-22.
19. Haas AJ. Palatal expansion; Just the beginning of dentofacial orthopedics. Am J Orthod. 1970. 57: 219-255.
20. Memikoglu T, Iseri H. Effects of a bonded rapid maxillary expansion appliance during orthodontic treatment. Angle Orthod. 1999. 69: 251-256.
21. McLaughlin RP, Bennett JC, Trevisi H. Systemized orthodontic treatment mechanics; London: Mosby. 2001. 33-34.
22. Jain M, Varghese J, Mascarenhas R, Mogra S, Shetty S, et al. Assessment of clinical outcomes of Roth and MBT bracket prescription using the American Board of Orthodontics Objective Grading System. Contemp Clin Dent. 2013. 4: 307-312.
23. Chhibber A, Upadhyay M, Uribe F, Nanda R. Mechanism of Class II correction in prepubertal and postpubertal patients with Twin Force Bite Corrector. Angle Orthod. 2013. 83: 718-727.
24. Chhibber A, Upadhyay M, Uribe F, Nanda R. Long-Term Stability of Class II Correction with the Twin Force Bite Corrector; JCO. 2010. 6: 363-376.
25. Proffit WR. Contemporary orthodontic appliances. In: Profitt WR, Fields HW Jr, Sarver DM, eds. Contemporary Orthodontics. 4th ed. St Louis, Mo: Elsevier. 2007. 2007: 395-430.
26. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, et al. Effectiveness of treatment for Class II malocclusion with the Herbst or Twinblock appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop. 2003. 124: 128-137.
27. Ruf S, Pancherz H. Dentoskeletal effects and facial profile changes in young adults treated with the Herbst appliance. Angle Orthod. 1999. 69 :239-246.
28. Ku¨c¸u¨kkeles¸ N, Ilhan I, Orgun IA. Treatment efficiency in skeletal Class II patients treated with the jasper jumper. Angle Orthod. 2007. 77: 449-456.
29. Heinig N, Go¨z G. Clinical application and effects of the Forsus spring. A study of a new Herbst hybrid [in English, German]. J Orofac Orthop. 2001. 62: 436-450.
30. Herrera FS, Henriques JF, Janson G, Francisconi MF, de Freitas KM. Cephalometric evaluation in different phases of Jasper jumper therapy. Am J Orthod Dentofacial Orthop. 2001. 140: 77-84.
31. Woodside DG, Altuna G, Harvold E, Herbert M, Metaxas A. Primate experiments in malocclusion and bone induction. Am J Orthod Dentofacial Orthop. 1983. 83: 460-468.

32. McNamara JA Jr, Bryan FA () Long term mandibular adaptations to protrusive function: an experimental study in Macaca mulatta. Am J Orthod Dentofacial Orthop. 1987. 92: 98-108.
33. Charlier JP, Petrovic AG, Stutzmann J. Effects of mandibular hyperpropulsion on the prechondroblastic zone of rat condyle. Am J Orthod Dentofacial Orthop. 1969. 55: 71-74.
34. Stockly P, Willert H. Tissue reactions in the temporomandibular joint resulting from anterior displacement of the mandible in the monkey. Am J Orthod Dentofacial Orthop. 1971. 60: 142-155.
35. Mills JR. The effect of functional appliances on the skeletal pattern. J Orthod. 1991. 18: 267275.
36. Almeida MR, Henriques JF, de Almeida RR, Ursi W. Treatment effects produced by Frankel appliance in patients with Class II, division 1 malocclusion. Angle Orthod. 2002 72: 418-425.
37. Perillo L, Johnston LE, Ferro A. Permanence of skeletal changes after function regulator (FR2) treatment of patients with retrusive Class II malocclusions. Am J Orthod Dentofacial Orthop. 1996. 109: 132-139.
38. Almeida MR, Henriques JF, Ursi W. Comparative study of the Frankel (FR-2) and bionator appliances in the treatment of Class II malocclusion. Am J Orthod Dentofacial Orthop. 2002. 121: 458-466.
39. Toth LR, McNamara JA Jr. Treatment effects produced by the twin-block appliance and the Fr-2 appliance of Frankel compared with an untreated Class II sample. Am J Orthod Dento facial Orthop. 1999. 116: 597-609.
40. Baltromejus S, Ruf S, Pancherz H. Effective temporomandibular joint growth and chin position changes: activator versus Herbst treatment. A cephalometric roentgenographic study. Eur J Orthod. 2002. 24: 627-637.
41. Croft RS, Buschang PH, English JD, Meyer R. A cephalometric and tomographic evaluation of Herbst treatment in the mixed dentition. Am J Orthod Dentofacial Orthop. 1999 116: 435443.
42. Pancherz H, Ruf S, Kohlhas P. Effective condylar growth and chin position changes in Herbst treatment: a cephalometric roentgenographic long-term study. Am J Orthod Dentofacial Orthop. 1998. 114: 437-446.
43. Ruf S, Baltromejus S, Pancherz H . Effective condylar growth and chin position in activator treatment: a cephalometric roentgenographic study. Angle Orthod. 2001. 71: 4-11.
44. Creekmore TD, Radney LJ. Frankel appliance therapy: orthopedic or orthodontic? Am J Orthod Dentofacial Orthop. 1983. 83: 89-108.
45. Giannelly A, Bronson P, Martignoni M, Bernstein L. Mandibular growth, condylar position and Frankel appliance therapy. Angle Orthod. 1983. 53: 131-142.
46. Vargervik K, Harvold EP. Response to activator treatment in Class II malocclusions. Am J Orthod Dentofacial Orthop. 1985. 88: 242-251.
47. Wieslander L, Lagerstrom L. The effect of activator treatment on Class II malocclusions. Am J Orthod Dentofacial Orthop. 1979. 75: 20-26.
48. Robertson NRE. An examination of treatment changes in children treated with the functional regulator of Frankel. Am J Orthod Dentofacial Orthop. 1983. 83: 299-310.
49. Janson GR, Toruno JL, Martins DR, Henriques JF, de Freitas MR. Class II treatment effects of the Frankel appliance. Eur J Orthod. 2003. 25: 301-309.
50. Erverdi N. A cephalometric study of changes in point A under the influence of upper incisor inclination. J Nihon University School of Dentistry. 1991. 33: 160-165.
51. Arvysts MG. Nonextraction treatment of severe Class II division 2 malocclusion: part 1. Am J Orthod Dentofacial Orthop. 1990. 97: 510-521.
52. Arvysts MG. Nonextraction treatment of severe Class II division 2 malocclusion: part 2. Am J Orthod Dentofacial Orthop. 1991. 99: 74-84.
53. Al-Nimri K, Hazza'a A, Al-Omari R. Maxillary Incisor Proclination Effect on the Position of Point A in Class II division 2 Malocclusion; Angle Orthod. 2009. 79: 880-884.
54. Aidar A, Scanavini M. Estudo comparativo cefalométrico radiográfico dos padrões de crescimento facial em pacientes portadores de oclusão normal e maloclusões de Classe I, Classe II, divisão 1, Classe II, divisão 2, e Classe III, de Angle, de acordo com Siriwat Jarabak. Ortodontia, São Paulo, maio/ago. 1989. 22: 31-52.
55. Proffit WR. Contemporary orthodontics. St Louis: CV Mosby. 1993. 239.
56. McNamara JA Jr, Brudon WL. Orthodontic and orthopedic treatment in the mixed dentition. Ann Arbor, Mich: Needham Press. 1993. 133.
57. Bishara SE, Staley RN. Maxillary expansion: clinical implications. Am J Orthod Dentofacial Orthop. 1987. 91: 3-14.
58. McNamara JA Jr. The role of the transverse dimension in orthodontic diagnosis and treatment planning. Monograph 36. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development; University of Michigan. 1999.
59. Handelman CS, Wang L, BeGole EA, Haas AJ. Nonsurgical rapid maxillary expansion in adults: report on 47 cases using the Haas expander. Angle Orthod. 2000. 70: 129-144.
60. Lagrav_ere MO, Major PW, Flores-Mir C. Long-term dental arch changes after rapid maxillary expansion treatment: a systematic review. Angle Orthod. 2005. 75: 155-161.
61. McNamara JA Jr, Baccetti T, Franchi L, Herberger TA. Rapid maxillary expansion followed by fixed appliances: a long-term evaluation of changes in arch dimensions. Angle Orthod. 2003. 73: 344-353.
62. Krebs A. Expansion of the midpalatal suture studied by means of metallic implants. Trans Eur Orthod Soc. 1958. 34: 163-171.
63. Krebs A. Midpalatal suture expansion studies by the implant method over a seven year period. Trans Eur Orthod Soc. 1964. 40: 131-142.
64. Iseri H, Ozsoy S (2004) Semirapid maxillary expansion a study of longterm transverse effects in older adolescents and adults. Angle Orthod 74: 71-78.
65. Araújo E, Araújo C. Abordagem clínica nãoirúrgica no tratamento da má oclusão de Classe III. Rev. Dent. Press Ortodon. Ortop. Facial. 2008 .13.
66. Alavi DG, BeGole EA, Schneider BJ Facial and dental arch asymmetries in Class II subdivision malocclusion. Am J Orthod Dentofacial Orthop. 1988. 93: 38-46.

67. Rose JM, Sadowsky C, Begole EA, Moles R. Mandibular skeletal and dental asymmetry in Class II subdivision malocclusions. Am J Orthod Dentofacial Orthop. 1994. 105: 489-495.
68. Janson GR, Metaxas A, Woodside DG, de Freitas MR, Pinzan A. Three-dimensional evaluation of skeletal and dental asymmetries in Class II subdivision malocclusions. Am J Orthod Dentofacial Orthop. 2001. 19: 406-418.
69. Janson G, de Lima KJ, Woodside DG, Metaxas A, de Freitas MR, et al. Class II subdivision malocclusion types and evaluation of their asymmetries. Am J Orthod Dentofacial Orthop. 2007. 131: 57-66.
70. Cassidy S, Jackson S, Turpin D, Ramsay D, Spiekerman C, et al. Classification and treatment of Class II subdivision malocclusion; Am J Orthod Dentofacial Orthop. 2014. 145: 443-451.
71. Herrera FS, Henriques JF, Janson G, Francisconi MF, de Freitas KM. Cephalometric evaluation in different phases of Jasper jumper therapy. Am J Orthod Dentofacial Orthop. 2001. 140: 77-84.
72. Pancherz H, Anehus-Pancherz M. The headgear effect of the Herbst appliance: a cephalometric long term study. Am J Orthod Dentofacial Orthop. 1993. 103: 510-520.
73. Stucki N, Ingervall B. The use of the Jasper Jumper for the correction of Class II malocclusion in the young permanent dentition. Eur J Orthod. 1998. 20: 271-281.
74. Jones G, Buschang PH, Kim KB, Oliver DR. Class II non-extraction patients treated with the Forsus fatigue resistant device versus intermaxillary elastics. Angle Orthod. 2008. 78: 332-338.
75. Bishara SE, Hoppens BJ, Jakobsen JR, Kohout FJ. Changes in the molar relationship between the deciduous and permanent dentitions: a longitudinal study. Am J Orthod Dentofacial Orthop. 1988. 93: 19-28.
76. Abhay K Jain, Anand K Patil, Sanjay V Ganeshkar, B Sangamesh, Tina Chugh. Nonextraction treatment of skeletal class II malocclusion; Contemp Clin Dent. 2012. 3: 334-337.
77. Arici S, Akan H, Yakubov K, Arici N. Effects of fixed functional appliance treatment on the temporomandibular joint; Am J Orthod Dentofacial Orthop. 2008. 133: 809-814.
78. Karacay S, Akin E, Olmez H, Gurton A, Sagdic D. Forsus Nitinol Flat Spring and Jasper Jumper Corrections of Class II division 1 Malocclusions; Angle Orthod. 2006. 76: 666-672.