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# USE OF CARRIERE MOTION CLASS III APPLIANCE (CM3) IN THE TREATMENT OF SKELETAL MALOCCLUSION CLASS III IN MINIMALLY GROWING PATIENTS – CASE REPORT

# УПОТРЕБА НА CARRIERE MOTION III АППАРАТ (CM3), ВО ТРЕТМАН НА СКЕЛЕТНА МАЛОКЛУЗИЈА КЛАСА III КАЈ ПАЦИЕНТИ СО МИНИМАЛЕН РАСТ - ПРИКАЗ НА СЛУЧАЈ

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## Abstract

**Introduction:** Class III malocclusions include spectrum of antero-posterior irregularities ranging from dentoalveolar problems with functional anterior shift of the mandible to really serious skeletal maxillomandibular discrepancies. Due to its variety of clinical presentation, there are many therapeutical modalities. Although optimal treatment approach to skeletal class III is orthognathic surgery complemented by orthodontics, many patients refuse it, yet,they expect good outcome. One of the treatment alternatives in such cases is the use of Carriere Motion Class III (CM3) appliance. **Aim:** To describe the treatment effects of CM3 appliance prior bonding fixed appliances in the treatment of minimally growing patients with skeletal class III. **Method:** CM3 appliance was fixed in the mandible in combination with trans palatal arch and vacuum-formed retainer in the maxilla as an anchorage. Class III intermaxillary elastics were used from the moment of application of CM3 appliance, all three months prior the bonding of the fixed appliances. **Results:** After 3 months of treatment with CM3, dental class I relationship was achieved. Together with the immediate therapy with fixed appliances, positive overjet was attained. The consecutive reduction of the profile convexity and lower lip prominence led to improvement of the patient's extraoral appearance. **Conclusion:** CM3 appliance provides a novel approach of the management of class III in mature or minimally growing patients. This protocol offers an alternative to more aggressive therapies that can involve orthodontics alone or in combination with orthognathic surgery. **Key words:** skeletal class III malocclusion, non-growing patient, Carriere Motion Class III appliance, mandibular molar distalization, camouflage treatment.

## Апстракт

**Вовед:** Малоклузиите III класа опфаќаат спектар на неправилности во антеро-постериорен правец, кои се движат од дентоалвеоларни промени со функционално антериорно придвижување на мандибулата, до сериозни скелетни максило-мандибуларни дискрепанци. Со оглед на разновидноста на клиничката манифестација, постојат многу тераписки модалитети. Иако оптимален тераписки пристап во лекувањето на скелетна трета класа е ортогната хирургија, голем дел од пациентите одбиваат, а и покрај тоа, очекуваат добар тераписки исход. Една од терапевтските алтернативи во вакви случаи е употреба на Carriere Motion Class III (CM3) апаратот. **Цел:** да се прикаже терапевтскиот ефект на CM3 апаратот пред бондирање на фиксните апарати, кај пациент со минимален раст и скелетна класа III. **Метод:** CM3 апаратот беше аплициран во мандибулата, во комбинација со транспалатинален лак и ретејнер формиран со вакуум формер апарат во максилата како упориште. Дадени беа инструкции за употреба на интермаксиларна тракција III класа во вкупно времетраење од 3 месеци пред поставувањето на фиксните апарати. **Резултати:** По 3 месеци терапија со CM3беше постигнат правилен меѓувиличен сооднос- дентална прва класа. Во комбинација со непосредната терапија со фиксни апарати, добивме позитивнахоризонтална инцизивна стапалка. Последователната редукција на конвекситетот на профилот и проминенцијата на долната усна, доведоа до подобрување на екстраоралниот изглед на пациентот. **Заклучок:** CM3 апаратот нуди нов пристап при менаџирањето на класа III кај адултни или пациенти со минимален раст. Овој протокол нуди алтернатива на поагресивни терапии од ортодонтска или ортодонтско-хируршка природа. **Клучни зборови:** скелетна малоклузија класа III, пациент со завршен раст, Carriere Motion Class III апарат, дистализација на мандибуларни молари, камуфлажна терапија.

## Introduction

Class III malocclusions include spectrum of antero-posterior irregularities, which can range in severity - from dentoalveolar problems with functional anterior shift of the mandible to true skeletal problems with serious maxillomandibular discrepancies[1], where mesial relationship (anteposition) of mandible to the maxilla and/or cranial base is presented. The nature of this malocclusion can be of dentoalveolar or skeletal nature.

Class III malocclusions are the least common type of malocclusion, yet they are often more complicated to treat and more likely to require orthognathic surgery for optimal correction[2]. The reported incidence of this malocclusion ranges between 1% to 19%, with the lowest prevalence among the Caucasian populations[3,4] and the highest one among the Asian populations[5,6].

Despite its low incidence, the treatment of this malocclusion becomes huge challenge for the therapist, because even if early-diagnosed and interceptive, and early treatment measures are being undertaken, the factor of growth in later stages of development (pic of puberty), can compromise the achieved results, and the long-term outcome still remains uncertain.

Class III malocclusions can be generally categorized into two groups: developing and non-developing[7]. Regarding thedevelopment stage of the individual (growing or non-growing patient), and the severity of the malocclusion (dentoalveolar or underlying skeletal irregularity), there is a variety of treatment modalities in such cases.

For correction of skeletal Class III malocclusion, Proffitt states that there are three treatment options:

1) growth modification, use differential growth of the maxilla relative to the mandible;
2) camouflage of the skeletal discrepancy through tooth movements to correct the dental occlusion while maintaining the skeletal discrepancy; or
3) orthognathic surgical correction[8]. The treatment option is depending on the patient's age, the facial profile, the skeletal pattern, the alveolar bone reaction on mandibular incisors, and the severity of malocclusion before treatment[9].

Optimal treatment of a Class III malocclusion with skeletal disharmony requires orthognathic surgery complemented by orthodontics[10]. Treatment of these patients becomes even more challenging if they reject surgery but expect good outcome over the orthodontic therapy applied. Many therapeutical options are being suggested in such cases, including extractions (usually mandibular premolars), extraoral traction (horizontal traction of mandibular dental arch) or distalization of mandibular molars using different types of appliances[11,12,13].

This case report describes the therapeutical approach of resolving malocclusion Class III with underlying skeletal discrepancy, with camouflage treatment using Carriere Motion Class III Appliance (CM3) in patient refusing orthognathic surgery.

## Appliance design

The design of Carriere Motion Class III Appliance was based on the principles of respect for human biology and the concepts of simplicity, biomimetics and biominimalism[14]. The anterior segment has a pad that bonds directly to the lower canine, with a hook for attachment of Class III elastics. An arm extends distally over the two lower premolars, with a slight curve following the contours of the dental arch and is bonded to the lower first molar by means of a distal pad. This rigid, half-round arm controls the lower canines while directing movement longitudinally. Between the second premolar and the first molar, it diminishes in size and forms an offset with a bayonet bend and toe-in angle, designed to produce a mild 10° distal rotation of the first molar. The bayonet bend has multilateral flexion to closely fit the patient's anatomical structure and facilitate the rotation; the posterior segment is flat to avoid interference with the maxillary teeth or brackets. Class III intraoral elastics connect the appliance with maxillary anchorage (either bonded appliances or a vacuum-formed retainer) to activate the mandibular posterior segment[15], moving it bodily into Class I relationship from canines to molars.

## Diagnosis

An 18y3m old male patient was presented for treatment of mandibular prognathism. His chief complaint was bite discomfort and his unsatisfactory aesthetic appearance.

Extra oral findings of the patient revealed mandibular prognathism; concave profile with protruded lower third of the face, and thin retrusive upper lip. The frontal view showed an enlarged height of the lower facial third and mild facial hemihypertrophy on the right side (Figure 1).

Clinical examination revealed irregularities in both dental arches, mild crowding in the mandibular front, „tete-a-tete" bite, Class ½ III molar and canine relationship on the left side and full Class III molar and canine relationship on the right side (Figure 2).

The orthopantomogram showed that all permanent teeth are present and there is good bone support in general (Figure 3).

The skeletal analysis presented hypoplastic maxilla (maxillary retrognathism) with SNA value of 78 degrees, mandibular normognatism with SNB value of 81.2 degrees, a severe Class III skeletal relationship with ANB value of 3.2 degrees and Witts value of -6.1mm. The cephalogram analysis revealed tendency to skeletal open bite. The maxillary incisors were in severe protrusion and the mandibular incisors were slightly retruded. The patient was presented with an anterior growth pattern (Table 1).

In terms of muscular balance and function, we observed slight hypertonicity in the musculature in the

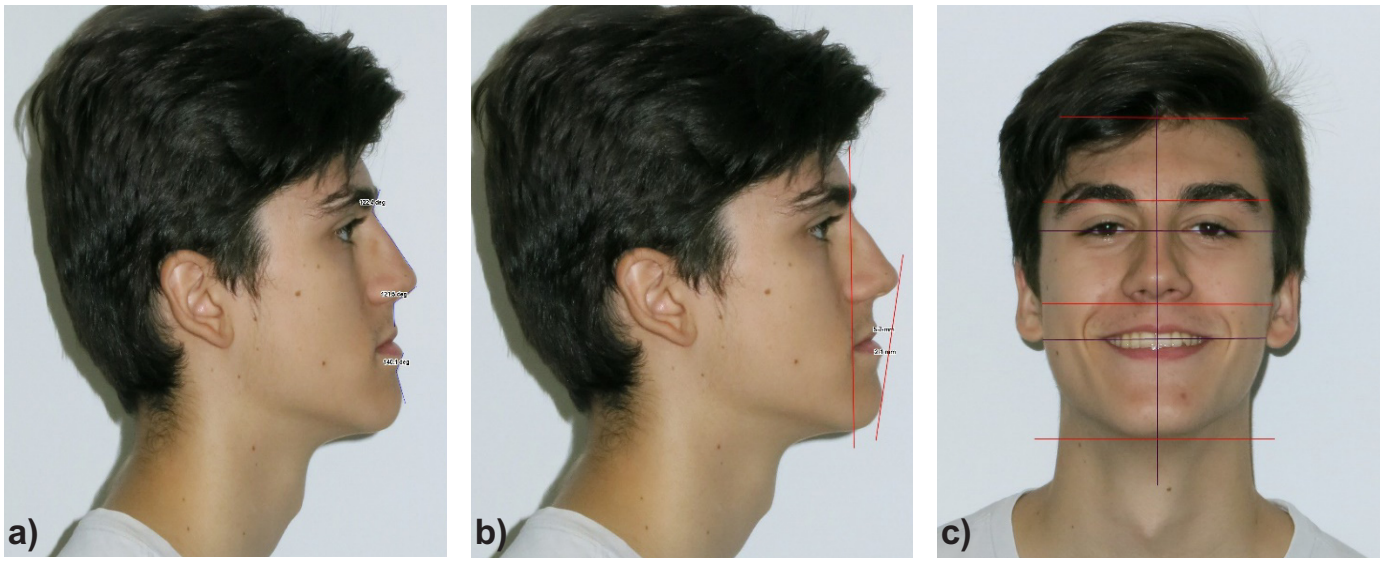


***Figure 1. (a),(b),(c)*** *Pre treatment soft tissue analyses*

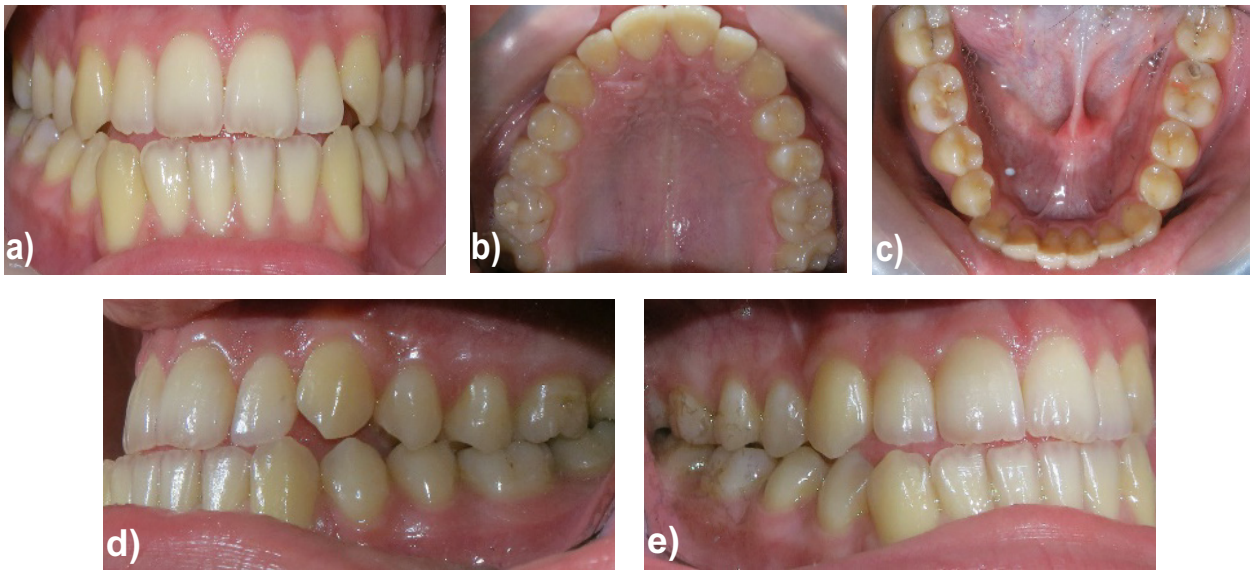


***Figure 2. (a),(b),(c),(d),(e)*** *Pre treatment intraoral photographs*

***Figure 3.*** *Pre treatment orthopantomogram*

right side, as well as tongue thrust at deglutition. At rest, the tongue posture was on the floor of the mouth.

Although the patient was 18y3m old, his CVM analyses on the lateral cephalogram showed skeletal maturation stage 5. The means of the analyses is that his growth peak has already passed, but some horizontal growth is still expected, and an increase of mandibular body length (Table 2).

**Table 1.** Pre treatment cephalometric analyses

| Measurement | Value | Normal | Std.Dev | Dev.Norm |
|---|---|---|---|---|
| Saddle/Sella Angle (SN-Ar) (ϵ) | 118.7 | 124.0 | 5.0 | -1.1 |
| Articular Angle (ϵ) | 152.7 | 138.0 | 6.0 | 2.4 |
| Gonial/Jaw Angle (Ar-Go-Me) (ϵ) | 119.6 | 120.8 | 6.7 | -0.2 |
| Sum Total: N-S-Art + S-Art-Go + Art-Go-Me (ϵ) | 391.0 | 396.0 | 4.0 | -1.3 |
| Anterior Cranial Base (SN) (mm) | 68.5 | 77.3 | 3.0 | -3.0 |
| Posterior Cranial Base (S-Ar) (mm) | 35.8 | 37.0 | 4.0 | -0.3 |
| Nasion-Gonion Length (mm) | 118.0 | 134.4 | 4.0 | -4.1 |
| Y-Axis Length (mm) | 135.6 | 140.0 | 6.0 | -0.7 |
| SNA (ϵ) | 78.0 | 82.0 | 3.5 | -1.2 |
| SNB (ϵ) | 81.2 | 80.9 | 3.4 | 0.1 |
| ANB (ϵ) | -3.2 | 1.6 | 1.5 | -3.2 |
| Beta Angle (ϵ) | 42.7 | 31.0 | 4.0 | 2.9 |
| Wits Appraisal (mm) | -6.1 | -1.0 | 1.0 | -5.1 |
| Convexity (NA-APo) (ϵ) | -10.7 | 2.5 | 3.0 | -4.4 |
| Anterior Face Height (NaMe) (mm) | 121.8 | 139.0 | 5.0 | -3.4 |
| Posterior Face Height (SGo) (mm) | 83.5 | 90.0 | 5.0 | -1.3 |
| P-A Face Height (S-Go/N-Me) (%) | 68.5 | 65.0 | 4.0 | 0.9 |
| Lower Face Height (ANS-Xi-Pm)(ϵ) | 47.2 | 45.0 | 4.0 | 0.6 |
| Facial Plane to SN (SN-NPog) (ϵ) | 83.2 | 82.0 | 4.0 | 0.3 |
| Y-Axis (SGn-SN) (ϵ) | 66.7 | 67.0 | 5.5 | -0.0 |
| Mandibular Body Length (Go-Gn)(mm) | 83.9 | 80.0 | 4.4 | 0.9 |
| Upper Gonial Angle (Ar-Go-Na) (ϵ) | 45.5 | 49.0 | 7.0 | -0.5 |
| Lower Gonial Angle (Na-Go-Me) (ϵ) | 74.1 | 72.0 | 6.0 | 0.3 |
| MP - SN (ϵ) | 31.0 | 33.0 | 6.0 | -0.3 |
| Ramus Height (Ar-Go) (mm) | 50.0 | 53.0 | 4.5 | -0.7 |
| FMA (MP-FH) (ϵ) | 24.7 | 22.9 | 4.5 | 0.4 |
| IMPA (L1-MP) (ϵ) | 90.1 | 95.0 | 7.0 | -0.7 |
| FMIA (L1-FH) (ϵ) | 65.2 | 65.7 | 8.5 | -0.1 |
| U1 - NPo (mm) | 0.5 | 5.0 | 2.0 | -2.3 |
| U1 - SN (ϵ) | 113.6 | 103.1 | 5.5 | 1.9 |
| U1 - NA (ϵ) | 35.6 | 22.8 | 5.7 | 2.2 |
| U1 - NA (mm) | 7.8 | 4.3 | 2.7 | 1.3 |
| L1 - NB (ϵ) | 22.3 | 25.3 | 6.0 | -0.5 |
| L1 - NB (mm) | 3.3 | 4.0 | 1.8 | -0.4 |
| L1 - Facial Plane (L1-NPo) (mm) | 0.5 | 1.0 | 2.0 | -0.3 |
| Mand Plane to Occ Plane (ϵ) | 18.3 | 18.6 | 5.0 | -0.1 |
| Interincisal Angle (U1-L1) (ϵ) | 125.3 | 130.0 | 6.0 | -0.8 |
| Lower Lip to E-Plane (mm) | -3.2 | -2.0 | 2.0 | -0.6 |
| Upper Lip to E-Plane (mm) | -7.6 | -8.0 | 2.0 | 0.2 |
| Z Angle (ϵ) | 82.0 | 75.0 | 4.0 | 1.8 |

*Table 2.* CVM analysis

| | Group/Measurement | Value |
|---|---|---|
| Depth of Concavity | | |
| | C2 Concavity (mm) | 1.7 |
| | C3 Concavity (mm) | 0.9 |
| | C4 Concavity (mm) | 1.6 |
| Shape of Body | | |
| | C3 Base Anterior Ratio (%) | 90.2 |
| | C3 Poserior Anterior Ratio (%) | 103.5 |
| | C4 Base Anterior Ratio (%) | 110.0 |
| | C4 Posterior Anterior Ratio (%) | 112.3 |
| SUMMARY ANALYSIS | | |
| | **C2 Concavity: Deep** | |
| | **C3 Concavity: Slight** | |
| | **C4 Concavity: Deep** | |

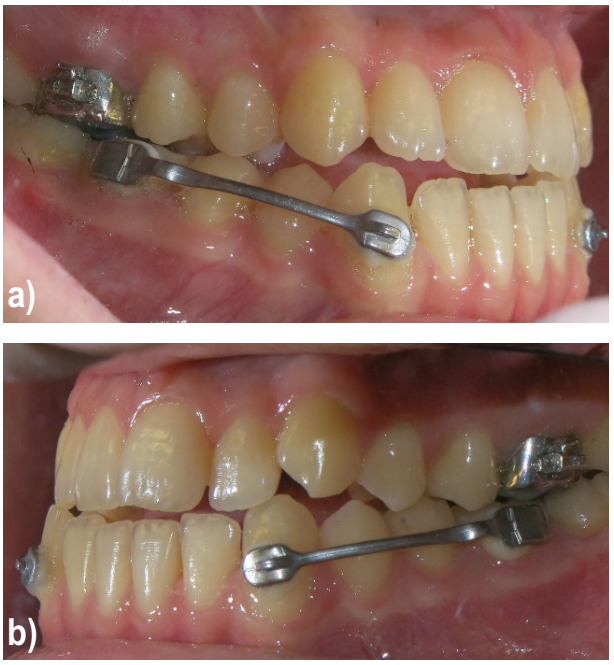


***Figure 4. (a),(b)*** *Treatment stage one*

## Treatment plan

Due to the underlying skeletal problems, orthognathic surgery was recommended, following the orthodontic therapy, but the patient and his family were strongly opposing surgery. Because of the severe proclination of the maxillary and retroinclination of the mandibular incisors, it was well-explained to the patient that camouflage therapy with extraction of the mandibular premolars was not an option. Then, a novel treatment solution using Carriere Motion Class III appliance was proposed, which is going to promote the correction of the dentoalveolar relationship as well as recovering to the proper mastication and improving facial and smile characteristics as a priority in the orthodontic treatment. The patient agreed with the given option.

To maximize mandibular dentoaveloar compensation, this protocol suggested extracting the mandibular third molars prior to the start of the treatment, to enable up-righting of the mandibular molars and to obtain space to retract the mandibular teeth.

## Treatment sequence

The patient started the first phase of the treatment at the age of 18y4m, with bonding of the Carriere Motion III appliance on the lower jaw, aiming to treat the malocclusion to a Class I occlusion by distalization of each mandibular posterior segment, from canine to molar, as a unit. As an anchorage in the upper jaw, trans palatal arch (TPA) was bonded on the upper first molars. We made a vacuum formed retainer (Essix retainer) for the upper dental arch in order to improve the anchorage. The patient was given Carriere force I elastics for class III (¼, 6 Oz), and was instructed to wear them from the mesial hooks on the appliance on the lower jaw to the upper first molars during the night and a maximum number of hours during the day. After three months of continuous wear of the elastics and regular monthly check-ups, with the Carriere Class III Motion Appliance, a Class I relationship was achieved in the posterior segment, completing stage one (Figure 4).

In the second phase of the treatment, after achieving anteroposterior correction, the upper and lower fixed appliance was bonded, and the treatment continued with proper leveling and aligning of the dental arches, and torque correction. The initial leveling and aligning started with Nickel titanium round wire 0.012 and by consequently increasing the dimension of the wire in order to achieve good expansion in the upper jaw. In the lower anterior segment, interproximal reduction was done in the first phases of alignment to provide enough space for incisor alignment and to avoid additional protrusion of the frontal segment. After achieving good expansion and dental alignment, Stainless Steel square wires were engaged in the bracket slot in order to emphasize good torque correction. During the treatment it was indicated to add additional bending of the wire of first, second and third order on certain teeth. The active phase of the treatment was finished with a SS 0.019X.025 wire.The inte-

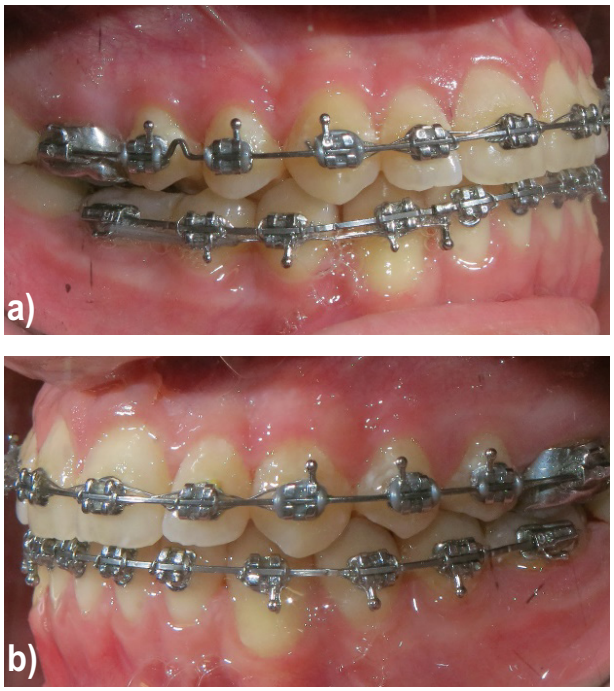


*Figure 5. (a),(b) Treatment stage two*

rocclusal relationships were controlled with short Class III elastics (3/16, 4,5 Oz), for a period of 1 year, which also improved the overjet and overbite (Figure 5). During this period, there was a short (3 months) interruption of the continuous orthodontic controls because of the Covid pandemic restrictions, the patient had missed few appointments and reported lesser compliance with wearing the elastics during that period.

After a total period of 2y3m, the treatment was successfully finished, achieving satisfactory dental alignment, Class I canine relationship on both sides, normal overjet and overbite and improved facial aesthetics (Figure 6). The patient was satisfied with his teeth and profile. Good intercuspation, interproximal contacts, and satisfactory root parallelism were achieved as well. The fixed appliances were removed, a 3-3 upper and lower lingual retainer was bonded, and a vacuum-formed aligner was delivered to retain the upper arch. For maintaining the mandibular position, functional appliance –activator, was given for the retention phase. Records taken 13 months after the end of the active treatment confirmed the stability of the results (Figure 7).


*Figure 6. (a),(b),(c),(d),(e) Removal of the fixed appliances*

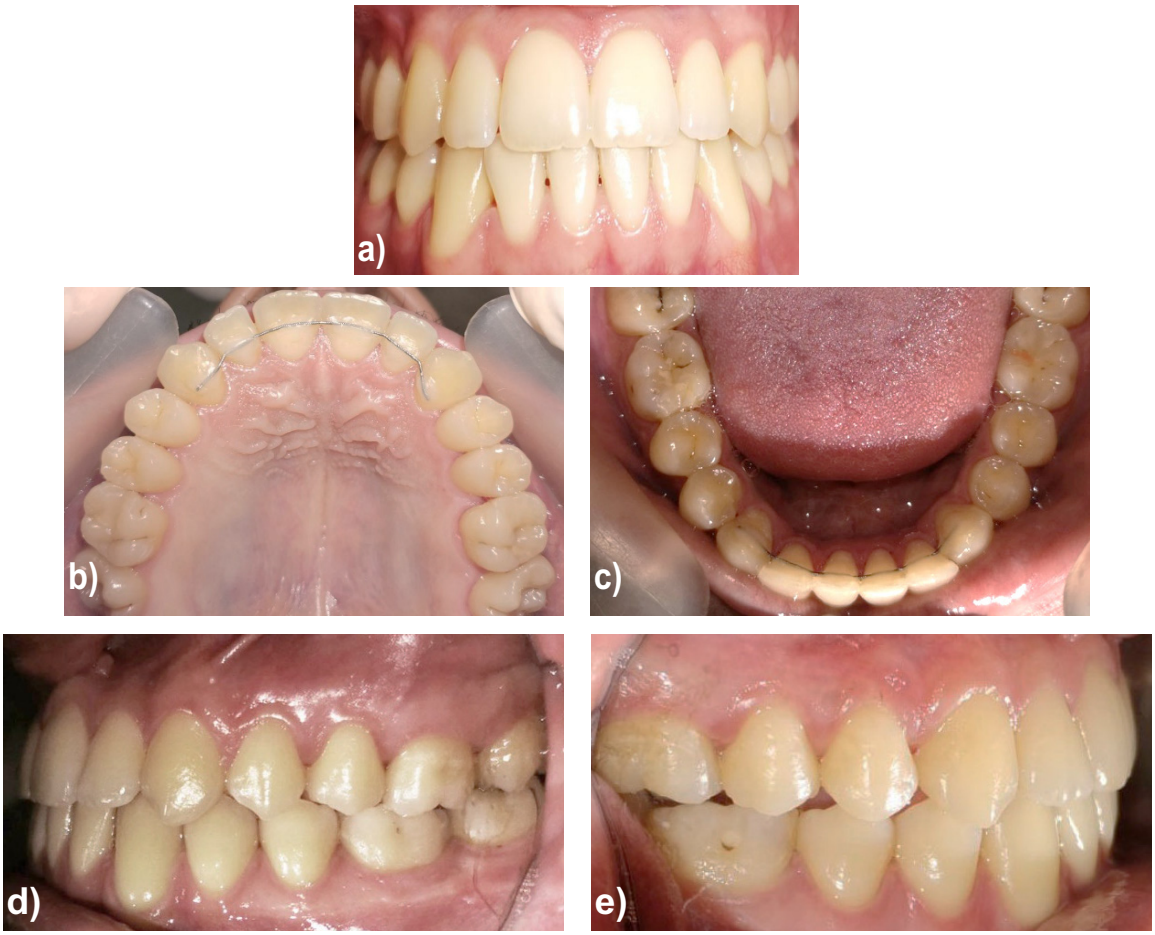


***Figure 7. (a),(b),(c),(d),(e)*** *13 months in retention*

## Treatment results

Cephalometric superimpositions indicated significant extrusion of upper molars. The upper incisors were slightly protruded for about 5 degrees. Lower molars were uprighted and moved distally, which improved the Class I dental relationship. The most significant change was made in the position of the lower incisors that were extruded and retruded, as well (Figure 8). All of this affected the occlusal plane which shifted in a counterclockwise rotation, as it can be seen in the change of the mandibular to occlusal plane angle in the cephalometric analyses (Table 3).

The vertical dimension was not altered, but the extraction of the lower third molars helped in controlling the vertical dimension in a patient who had a clinically long face.

The sagittal dimension was evidently improved, Class I canine relationship was achieved by the end of stage one, as the lower canines have been distalized enough to provide space for proper repositioning of the lower incisors, as determined by the diagnosis. The ANB angle didn't suffer any change, no skeletal effect was observed. But, at the end of treatment the Wits appraisal, reflecting the position of the dentition within their bony bases, was improved for 3.2 mm, and the therapy was finished with almost normal value (Table 4).

As it was expected, based on the values of the Bjork and the cervical vertebral maturation analyses, the values of mandibular prognathism mildly increased. The skeletal relationship between the upper and lower jaw didn't change at all, but the mandibular body length and forward position increased, the unfavorable growth was opposing the good results achieved with the appliance wear and made an insignificant increasement in the Z angle (Table IV). However, the soft tissue and smile line improved, due to the protrusion of the upper retrusive lip, into a more aesthetic and harmonious position, and better balance of the lower third was achieved by improving the mento-labial angle. The final profile was slightly improved even with the minimal unfavorable growth that had occurred (Figure 9).

**Table 3.** Post treatment cephalometric analyses

| Measurement | Value | Normal | Std.Dev | Dev.Norm |
|---|---|---|---|---|
| Saddle/Sella Angle (SN-Ar) (ϵ) | 118.7 | 124.0 | 5.0 | -1.1 |
| Articular Angle (ϵ) | 150.5 | 138.0 | 6.0 | 2.1 |
| Gonial/Jaw Angle (Ar-Go-Me) (ϵ) | 121.9 | 120.8 | 6.7 | 0.2 |
| Sum Total: N-S-Art + S-Art-Go + Art-Go-Me (ϵ) | 391.1 | 396.0 | 4.0 | -1.2 |
| Anterior Cranial Base (SN) (mm) | 67.9 | 77.3 | 3.0 | -3.1 |
| Posterior Cranial Base (S-Ar) (mm) | 36.9 | 37.0 | 4.0 | -0.0 |
| Nasion-Gonion Length (mm) | 117.9 | 134.4 | 4.0 | -4.1 |
| Y-Axis Length (mm) | 139.8 | 140.0 | 6.0 | -0.0 |
| SNA (ϵ) | 79.9 | 82.0 | 3.5 | -0.6 |
| SNB (ϵ) | 83.0 | --- 80.9 | 3.4 | 0.6 |
| ANB (ϵ) | -3.1 | 1.6 | 1.5 | -3.1 |
| Beta Angle (ϵ) | 43.2 | 31.0 | 4.0 | 3.1 |
| Wits Appraisal (mm) | -2.9 | -1.0 | 1.0 | -1.9 |
| Convexity (NA-APo) (ϵ) | -11.3 | 2.5 | 3.0 | -4.6 |
| Anterior Face Height (NaMe) (mm) | 124.5 | 139.0 | 5.0 | -2.9 |
| Posterior Face Height (SGo) (mm) | 84.4 | 90.0 | 5.0 | -1.1 |
| P-A Face Height (S-Go/N-Me) (%) | 67.7 | 65.0 | 4.0 | 0.7 |
| Lower Face Height (ANS-Xi-Pm)(ϵ) | 46.3 | 45.0 | 4.0 | 0.3 |
| Facial Plane to SN (SN-NPog) (ϵ) | 85.3 | 82.0 | 4.0 | 0.8 |
| Y-Axis (SGn-SN) (ϵ) | 65.8 | 67.0 | 5.5 | -0.2 |
| --Mandibular Body Length (Go-Gn)(mm) | 86.9 | 80.0 | 4.4 | 1.6 |
| Upper Gonial Angle (Ar-Go-Na) (ϵ) | 46.6 | 49.0 | 7.0 | -0.3 |
| Lower Gonial Angle (Na-Go-Me) (ϵ) | 75.3 | 72.0 | 6.0 | 0.6 |
| MP - SN (ϵ) | 31.1 | 33.0 | 6.0 | -0.3 |
| Ramus Height (Ar-Go) (mm) | 50.3 | 53.0 | 4.5 | -0.6 |
| FMA (MP-FH) (ϵ) | 24.6 | 22.9 | 4.5 | 0.4 |
| IMPA (L1-MP) (ϵ) | 78.4 | 95.0 | 7.0 | -2.4 |
| FMIA (L1-FH) (ϵ) | 77.1 | 65.7 | 8.5 | 1.3 |
| U1 - NPo (mm) | 1.5 | 5.0 | 2.0 | -1.8 |
| U1 - SN (ϵ) | 118.5 | 103.1 | 5.5 | 2.8 |
| U1 - NA (ϵ) | 38.6 | 22.8 | 5.7 | 2.8 |
| U1 - NA (mm) | 8.9 | 4.3 | 2.7 | 1.7 |
| L1 - NB (ϵ) | 12.5 | 25.3 | 6.0 | -2.1 |
| L1 - NB (mm) | 1.4 | 4.0 | 1.8 | -1.4 |
| L1 - Facial Plane (L1-NPo) (mm) | -1.7 | 1.0 | 2.0 | -1.3 |
| Mand Plane to Occ Plane (ϵ) | 24.8 | 18.6 | 5.0 | 1.2 |
| Interincisal Angle (U1-L1) (ϵ) | 132.0 | 130.0 | 6.0 | 0.3 |
| Lower Lip to E-Plane (mm) | -3.2 | -2.0 | 2.0 | -0.6 |
| Upper Lip to E-Plane (mm) | -6.4 | -8.0 | 2.0 | 0.8 |
| Z Angle (ϵ) | 84.4 | 75.0 | 4.0 | 2.3 |

**Table 4.** Comparison between pre and post treatment cephalometric values

| Measurement | Value | Normal | Std.Dev | Dev.Norm |
|---|---|---|---|---|
| Saddle/Sella Angle (SN-Ar) (ϵ) | 124.0 | 5.0 | 118.7 | 118.7 |
| Articular Angle (ϵ) | 138.0 | 6.0 | 152.7 | 150.5 |
| Gonial/Jaw Angle (Ar-Go-Me) (ϵ) | 120.8 | 6.7 | 119.6 | 121.9 |
| **Sum Total: N-S-Art + S-Art-Go + Art-Go-Me (ϵ)** | 396.0 | 4.0 | 391.0 | 391.1 |
| **SNA (ϵ)** | 82.0 | 3.5 | 78.0 | 79.9 |
| **SNB (ϵ)** | 80.9 | 3.4 | 81.2 | 83.0 |
| **ANB (ϵ)** | 1.6 | 1.5 | -3.2 | -3.1 |
| Beta Angle (ϵ) | 31.0 | 4.0 | 42.7 | 43.2 |
| **Wits Appraisal (mm)** | -1.0 | 1.0 | -6.1 | -2.9 |
| **Convexity (NA-APo) (ϵ)** | 2.5 | 3.0 | -10.7 | -11.3 |
| P-A Face Height (S-Go/N-Me) (%) | 65.0 | 4.0 | 68.5 | 67.7 |
| Lower Face Height (ANS-Xi-Pm)(ϵ) | 45.0 | 4.0 | 47.2 | 46.3 |
| Facial Plane to SN (SN-NPog) (ϵ) | 82.0 | 4.0 | 83.2 | 85.3 |
| Y-Axis (SGn-SN) (ϵ) | 67.0 | 5.5 | 66.7 | 65.8 |
| **Mandibular Body Length (Go-Gn)(mm)** | 80.0 | 4.4 | 83.9 | 86.9 |
| Upper Gonial Angle (Ar-Go-Na) (ϵ) | 49.0 | 7.0 | 45.5 | 46.6 |
| Lower Gonial Angle (Na-Go-Me) (ϵ) | 72.0 | 6.0 | 74.1 | 75.3 |
| MP - SN (ϵ) | 33.0 | 6.0 | 31.0 | 31.1 |
| **IMPA (L1-MP) (ϵ)** | 95.0 | 7.0 | 90.1 | 78.4 |
| FMIA (L1-FH) (ϵ) | 65.7 | 8.5 | 65.2 | 77.1 |
| U1 - NPo (mm) | 5.0 | 2.0 | 0.5 | 1.5 |
| **U1 - SN (ϵ)** | 103.1 | 5.5 | 113.6 | 118.5 |
| U1 - NA (ϵ) | 22.8 | 5.7 | 35.6 | 38.6 |
| U1 - NA (mm) | 4.3 | 2.7 | 7.8 | 8.9 |
| L1 - NB (ϵ) | 25.3 | 6.0 | 22.3 | 12.5 |
| L1 - NB (mm) | 4.0 | 1.8 | 3.3 | 1.4 |
| L1 - Facial Plane (L1-NPo) (mm) | 1.0 | 2.0 | 0.5 | -1.7 |
| Mand Plane to Occ Plane (ϵ) | 18.6 | 5.0 | 18.3 | 24.8 |
| **Interincisal Angle (U1-L1) (ϵ)** | 130.0 | 6.0 | 125.3 | 132.0 |
| Lower Lip to E-Plane (mm) | -2.0 | 2.0 | -3.2 | -3.2 |
| Upper Lip to E-Plane (mm) | -8.0 | 2.0 | -7.6 | -6.4 |
| **Z Angle (ϵ)** | 75.0 | 4.0 | 82.0 | 84.4 |
| **FMA (MP-FH) (ϵ)** | 22.9 | 4.5 | 24.7 | 24.6 |

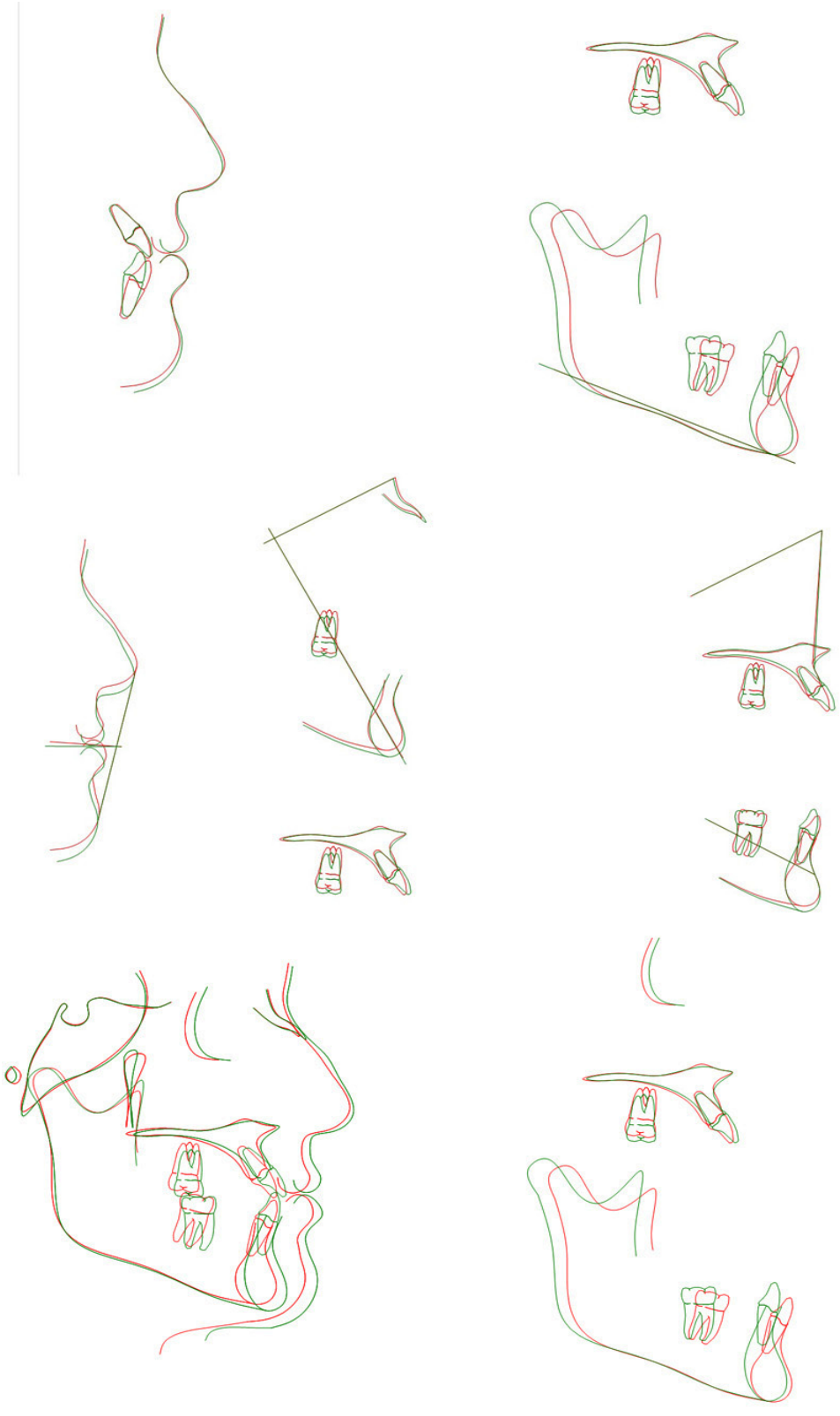

***Figure 8.*** *Superimposition of cephalometric analyses*

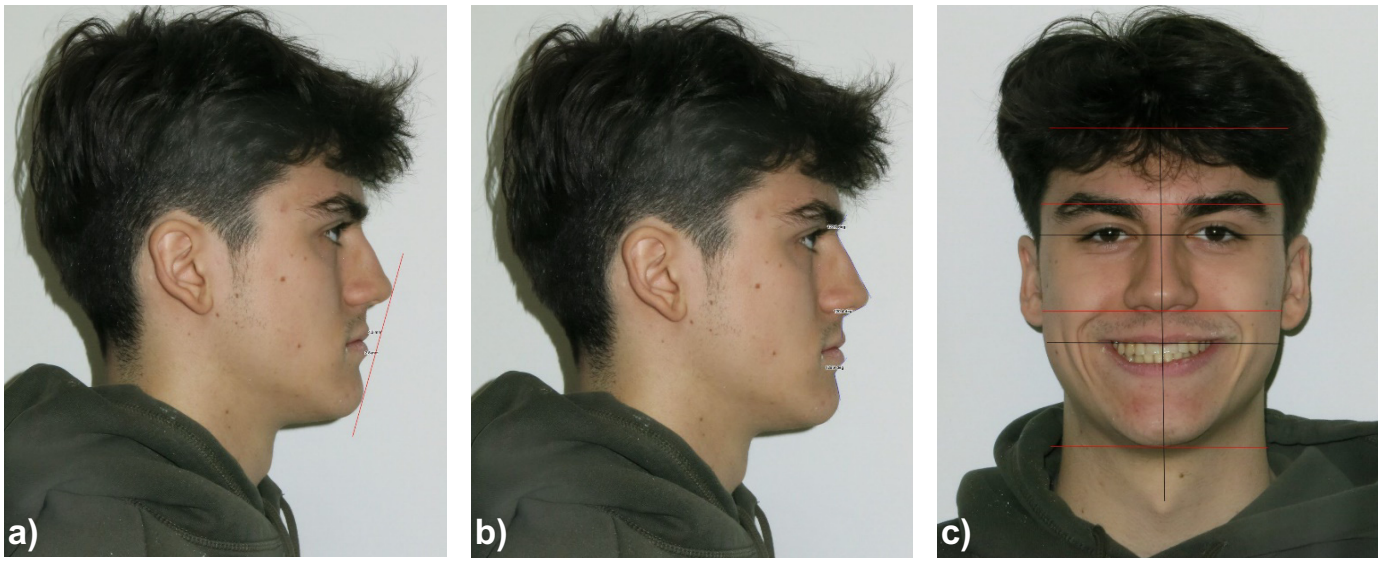


***Figure 9. (a),(b),(c)*** *Post treatment soft tissue analyses*

## Discussion

The Carriere Motion Class III appliance provides a novel approach of the management of Class III problems in mature or minimally growing patients. This protocol offers an alternative to more aggressive therapies that can involve orthodontics alone or a combination of orthodontics and orthognathic surgery, both with and without extraction of lower premolars.

Considering the limited literature concerning the Carriere Motion Class III appliance, the initial focus of this study was to describe in detail the treatment effects produced by the CM3 appliance on the relatively non-growing patient in whom the growth during treatment presumably would not be a factor.

Distalization is not the only effect of the Carriere Class III Motion Appliance, which is why it is not referred to as a distalizer. Clinical experience with this device has demonstrated skeletal and dental changes, alterations of the occlusal plane and the intermaxillary relationship, and improvement of soft tissue prognathic conditions.

Our findings are in concordance with the analysis of Luis Carriere (2016)[15], who also treated minimally/non-growing patient with The CM3 appliance and showed the same dentoalveolar changes that occurred during the treatment. With the Carriere III Motion appliance, the mandible is simultaneously repositioned for an improved sagittal relationship by counterclockwise movement of the posterior occlusal plane. To a certain degree, the appliance altered the relationship between the maxilla and the mandible by bringing the posterior occlusal plane into a better functional position, and thus balancing the face. Although, his study noticed slight skeletal changes that happened by functional repositioning of the condyle in the temporomandibular complex and which was confirmed by positive change in the ANB angle after the treatment, which we did not notice in our case, where most of the bigger changes were dentoalveolar.

The study of McNamaraet al.[16] analyzed 32 patients with Class III molar relationship, CVM stage greater than stage 4(minimally growing/non-growing). Statistically significant differences were observed in all dentoalveolar comparisons which correspond with our findings. No statistically significant or clinically relevant changes were noticed in the sagittal position of the maxilla. Only slight changes were observed in the position of the mandible. There was a mild decrease in the SNB angle (less than 1 degree) during the CM3 phase. The improvement in the facial aesthetics, looking at the Z angle and the decrease in the distance from the chin point at Pogonion to the Nasion perpendicular of 2.1 mm, noted in our study, was confirmed with the previous findings of McNamara.

Our study confirmed what the previous literature described, the Carriere Motion Class III appliance is an effective and efficient method of resolving occlusal problems in minimally growing Class III patients. Primary treatment effects are dentoalveolar in nature with minimal skeletal alterations that are not worth considering.

The patient was reluctant to undergo surgery, and he demonstrated a very compliant attitude toward the treatment demands, which is one of the most important factors contributing to the success of the treatment. The obtained satisfactory occlusal and aesthetic results were due to significant dentoalveolar compensation and excellent patient

compliance with elastics. The changes contributing most to the correction were maxillary incisor proclination, as well as the extrusion and bodily retrusion of the mandibular incisors with concurrent alveolar remodeling. These changes produced a counterclockwise rotation of the occlusal plane as expected.

Despite the limited articles about the effects of the CM3 appliance, the literature contains many studies[11,12,13] about compensational Class III therapy with lower bilateral bicuspid exraction. The achieved results have notable dentoalveolar changes, with significantly increased lower incisor reroinclination. No skeletal effect was noted and also no change in the functional occlusal plane as it can be seen in the final results achieved after the treatment with CM3 appliance. Also, the total treatment time for closing extraction spaces is greater than the total CM3 appliance followed by fixed braces. The great success of Class III correction, using the CM3, is due to establishing a Class I relationship at the beginning of treatment when patient compliance is high and before initiating the correction of the position and alignment of individual teeth with fixed appliances.

## Conclusion

In undertaking the decision to treat Class III condition with means of dentoalveolar compensation, the clinician must carefully weigh the benefits and costs of this choice. Considering the reluctance of the patient to undergo surgery, difficult decision must be made in selecting the most suitable compensating treatment plan for the patient, based on its individual values and diagnosis. Every compensation procedure has its benefits and costs as well as a restrictive factor. If extraction of lower teeth is contraindicated, and the benefits outweigh the costs, the treatment option of using Carriere Motion III appliance can be chosen. Otherwise, it would be better not to engage in orthodontic treatment in which a satisfactory result cannot be predicted.

The Carriere Motion Class III appliance is an effective and efficient adjunct to fixed appliances in the management of Class III malocclusion in mature patients. As shown in our study and observed in other studies, referring to the effects of the treatment with Carriere Motion III appliance, most of the treatment effects produced by the CM3 appliance were dentoalveolar in nature, with minimal skeletal adaptations observed. A counterclockwise rotation of the occlusal plane was evident. With good patient compliance using elastic wear, in minimally growing Class III patients, surgery can be avoided.

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