European Journal of Dental and Oral Health
Vol 5 | Issue 6 | December 2024
ISSN 2684-4443

CASE STUDY

Class III Malocclusion Treated with an Orthopedic Protraction Face Mask During Mixed Dentition, Followed by Invisalign Aligners to Correct Anterior Crossbite Occurring after Relapse During Adolescence

Salvador García-López[1,2,3,4,*] and Rosina Eugenia Villanueva Arriaga[1]

ABSTRACT

An eight-year-old male patient presented with a class III malocclusion on a skeletal class III pattern with an average lower face height, an anterior crossbite, slightly anterior lower crowding, and good oral hygiene; the parents were concerned about his crossbite. The aim of treatment was to correct the anteroposterior discrepancy by using a face mask during the 12-month mixed dentition period, during which the patient achieved a good result. However, after seven years of retention, the patient presented an anterior crossbite with a skeletal class I pattern and an average lower face height. He decided to wear clear aligners for treatment; 28 sets of clear aligners, which were changed every two weeks for twelve months, were necessary to achieve anterior crossbite correction.

Keywords: Class III malocclusion, Invisalign treatment, protraction facemask, relapse.

Submitted: October 20, 2024

Published: December 23, 2024

10.24018/ejdent.2024.5.6.351

[1] *Health Science Department, Universidad Autónoma Metropolitana, Mexico.*
[2] *Department of Orthodontics, Universidad Intercontinental, Mexico.*
[3] *Department of Orthodontics, Hospital General Dr. Manuel Gea González, UNAM, Mexico.*
[4] *Private Practice, Mexico.*

* ***Corresponding Author:***
e-mail: sgarcia@correo.xoc.uam.mx

1. Introduction

Class III malocclusions occur when the lower central incisal edges lie anterior to the cingulum plateau of the palatal surface of the upper central incisors [1]. Malocclusions are considered a public health problem [2]. The prevalence of grade III malocclusions, which depends on the geographic region, can vary from 3% to 28% [3]. As all malocclusions are caused by a deviation from the normality of average growth, their etiology is related mainly to genetic heredity due to the skeletal class III pattern and, to some extent, to environmental factors [4]; malocclusions are also associated with genes such as Indian hedgehog homolog (IHH), insulin-like growth factor-1 (IGF-1), vascular endothelial growth factor (VEGF), and parathyroid hormone-like hormone (PTHLH) [5]. The skeletal features include a reduced cranial base angle that contributes to the forward position of the mandible [6], along with maxillary retrusion that influences 60% of the cases; some cases involve a short cranial base, with a short maxillary portion that is small and narrow relative to the mandible, which tends to be broad, and the lower position of the tongue contributes to a posterior crossbite [7]. An obtuse gonial angle of the cranial base is related to an average or reduced lower face height, which also exhibits a transverse skeletal discrepancy [8]. Soft tissues are not involved in the etiology of malocclusions but facilitate dentoalveolar compensation for the skeletal base, pro-inclined upper incisors and retro-inclined lower incisors [9]. Facial growth tends to be unfavorable and unpredictable during adolescence.

Different treatment options, including functional appliances such as the Frankel type [10], protracted face mask [11], chin cap [12] and bone-anchored maxillary protraction [13], have been proposed for class III malocclusions that occur during the mixed dentition period. Early orthopedic treatment with a face mask is skeletally and dentally effective in the short term [14]; in the long term, some patients relapse to a negative overjet [15], and the skeletal change is not maintained after six years; 36% of patients need orthognathic surgery [16]. For those patients who relapse with anterior crossbite after short-term protraction face mask treatment [17], the first premolars and second molars in the upper arch could be extracted if the skeletal

Fig. 1. Pretreatment extraoral photographs.

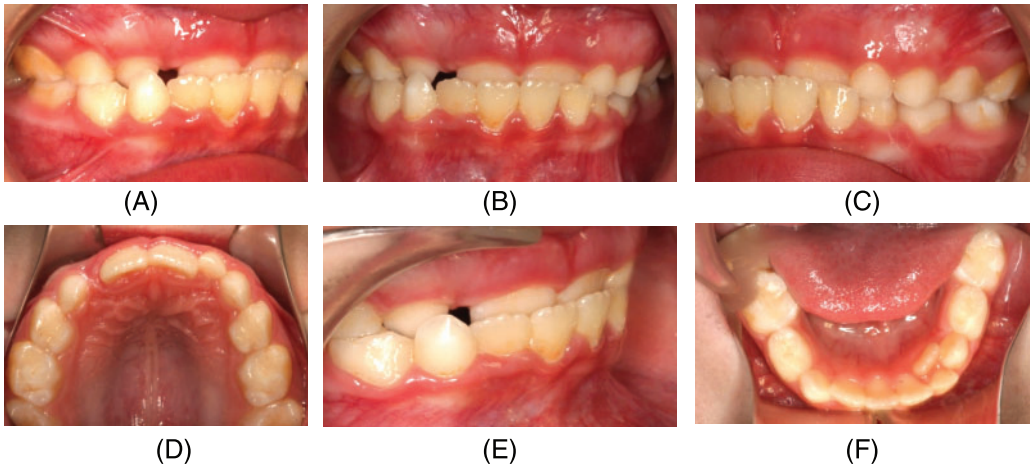


Fig. 2. Intraoral pretreatment photographs (A–F).

pattern allows camouflage of the malocclusion [18]; alternatively, it is possible to treat the anterior crossbite without extraction. Here, a case involving orthopedic face mask treatment during mixed dentition is presented; good results were obtained in the short term. However, the patient relapsed after seven years, producing an anterior crossbite in a skeletal I pattern; consequently, he was treated with clear aligners without extractions to correct the anterior crossbite through a comfortable and easy treatment.

2. Case Presentation

An eight-year-old male patient presented with a class III malocclusion in a skeletal class III pattern with an average lower face height, an anterior crossbite, slightly anterior lower crowding, and good oral hygiene.

2.1. Medical History

No abnormalities were determined according to the relevant medical history. The parents attended because they were concerned about their child's anterior crossbite, and the patient's attitude was keen.

2.2. Clinical Examination

Soft Tissue Pattern: During the evaluation of the patient's soft tissue pattern, the lips were competent, the tongue functioned with an upper incisor/palate swallowing pattern. Moreover, there was no relevant history of past habits, and the temporomandibular joint showed no evidence of TMJ dysfunction. The patient was in mixed dentition and had no apparent facial asymmetry (Fig. 1).

2.3. Occlusion

There was a class III incisor relationship, and the centerline was well aligned, with an overjet of 3 mm and an overbite of 4 mm. The buccal occlusion on both sides exhibited a class III relationship, there was no crowding in the upper and lower labial segments, and the upper and lower labial segments were well aligned. However, the patient exhibited an anterior crossbite, albeit with no mandibular anterior displacement (Fig. 2).

2.4. Etiology

The patient was determined to have a skeletal class III anterior crossbite.

2.5. Cephalometric

The McLaughlin cephalometric analysis confirmed the Class III skeletal pattern (ANB-1°) with a retrognathic maxillary (SNA 75.1°) and slightly retrognathic mandibula (SNB 76.1°), the upper incisors retroclined (UI/MX 99.8°), the lower incisors proclined (IMPA 103.5°), and the lower face height slightly decreased (FMA–MP-FH 25.4°) (Fig. 3; Table I). The panoramic X-ray revealed a mixed dentition patient without any pathological features. All teeth were present during this period of normal dentition development, and third molars were not visible (Fig. 4).

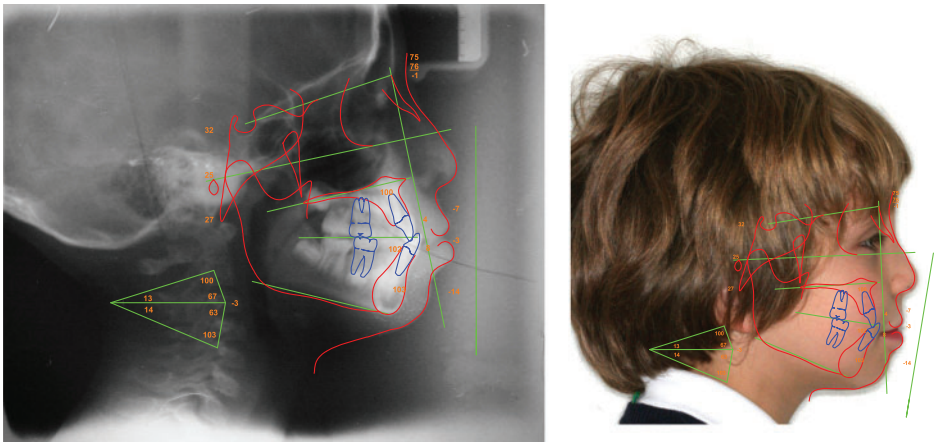


Fig. 3. McLaughlin cephalometric tracing confirmed the skeletal class III pattern with a slight reduction in the height of the lower face and reclining upper incisors and proclaiming lower incisors.

TABLE I: Pre-Treatment Cephalometric Analysis

Measurements	Value	Norm
Horizontal Skeletal		
SNA º	75.2	82.0
SNB º	76.1	80.0
ANB º	−0.9	2.0
Vertical Skeletal		
FMA (MP-PH) º	25.4	26
MP-SN º	32.0	33.0
Palatal-Mand Angle º	26.8	28.0
Palatal-Occ Plane º	13.0	10.0
Mand Plane to Occ Plane º	13.8	14.2
Mx occlusal plane (Mx OP-Na-Perp º	101.6	95.6
Anterior Dental		
U-Incisor protrusion (Ui-Apo) mm	4.0	6.0
L1 Protrusion (L1-Apo) mm	7.6	2.0
U1-Palatal Plane º	99.8	110.0
U1 Occ Plane º	67.2	54.0
L1 Occ Plane º	62.7	72.0
IMPA º	103.5	95.0

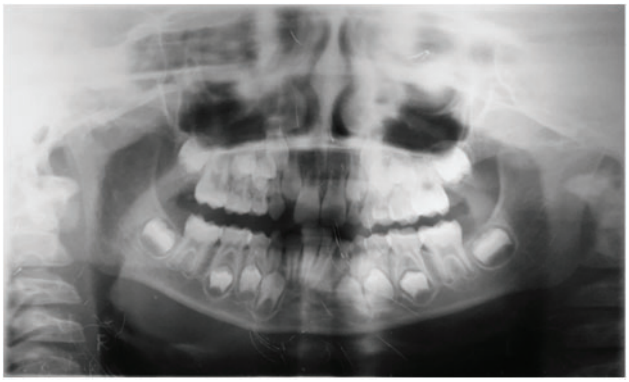


Fig. 4. Normal development during the mixed dentition, with no pathological features; the third molars are not visible.

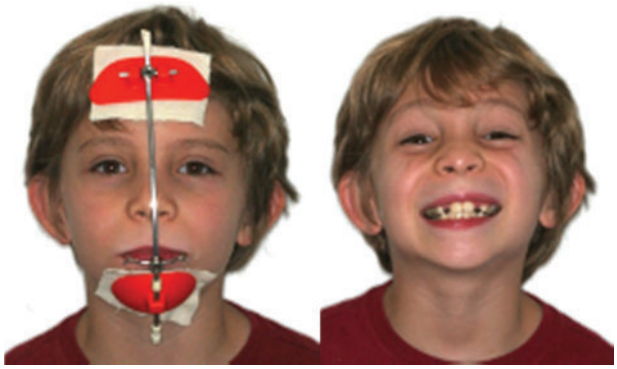


Fig. 5. The aim of the treatment was to correct the anteroposterior discrepancy via a protracted face mask during the mixed dentition period of 12 months.

2.6. *Aims of Treatment*

The therapeutic goals were to correct the anterior crossbite, establish a class I molar and canine relationship, and improve the anteroposterior discrepancy.

2.7. *Treatment Plan*

The first stage consists of the following:

1. Placement of a reverse headgear face mask (Fig. 5).
2. Review.

2.8. *Treatment Progress*

The patient was instructed to wear the face mask as much as possible. However, the pads produced tissue irritation; therefore, the patient had to place small pieces of cloth below the pads. At three months of treatment, the patient had an edge-to-edge incisor relationship. At six months of treatment, he exhibited a positive overjet; at this point, he had to wear the face mask only at night over a period of five months for retention. The patient was scheduled for removal of the face mask, after which he moved to the countryside for some time (Figs. 5 and 6).

After seven years of retention, the patient came in for a reassessment of their occlusion. He presented a class III incisor relationship involving the upper incisors (Figs. 7 and 8).

2.9. *Cephalometric*

The McLaughlin cephalometric analysis confirmed the Class I skeletal pattern (ANB 2.5°) with a retrognathic maxillary (SNA 76.3°) and slightly retrognathic mandibula

Fig. 6. During orthopaedic treatment (A, B, and C), The patient achieved good results after 7 months of treatment and 5 months of retention while wearing the face mask only at night (D, E, and F).

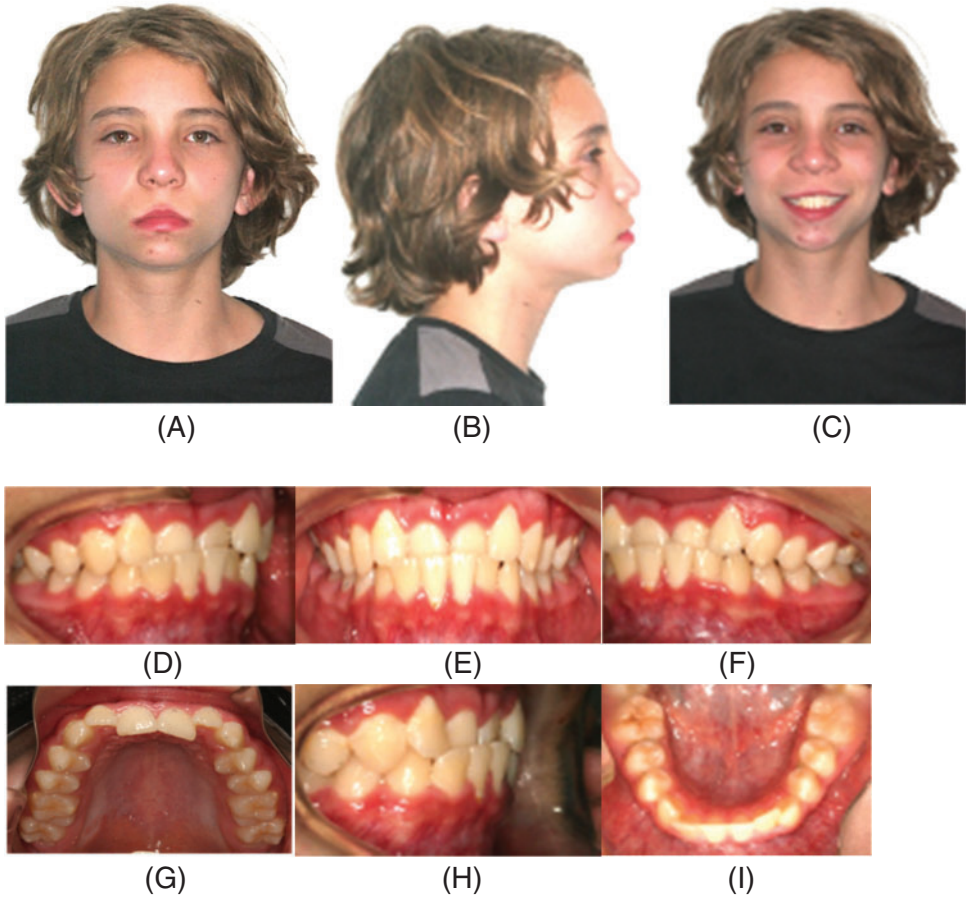


Fig. 7. After seven years out of retention, the patient presented an anterior crossbite in a skeletal class I pattern, with an average lower face height. Extraoral photographs (A, B and C), Intraoral photographs (D, F, F, G, H and I).

(SNB 73.8°), the upper incisors retroclined (UI/MX 94.8°), the lower incisors proclined (IMPA 103.6°), and average the lower face height (FMA–MP-FH 25.9°) (Table II).

An orthodontic simulation with clear aligners was shown to the patient. The patient decided to wear clear aligners for treatment, and optimized attachments were placed according to data from the ClinCheck software (Fig. 9).

2.10. Treatment Progress

The patient had to wear 28 sets of clear aligners, which were changed every two weeks for six months to achieve anterior crossbite correction very quickly.

3. Treatment Results

The posttreatment assessment revealed the following: The patient achieved facial balance (Fig. 10), a class I

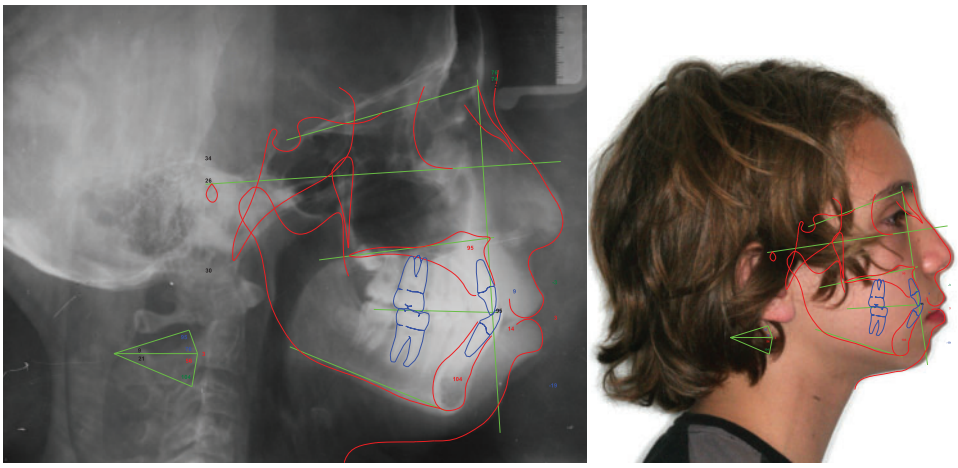


Fig. 8. McLaughlin cephalometric tracing confirmed the skeletal class I pattern with average in the height of the lower face and retroclining upper incisors and proclining lower incisors.

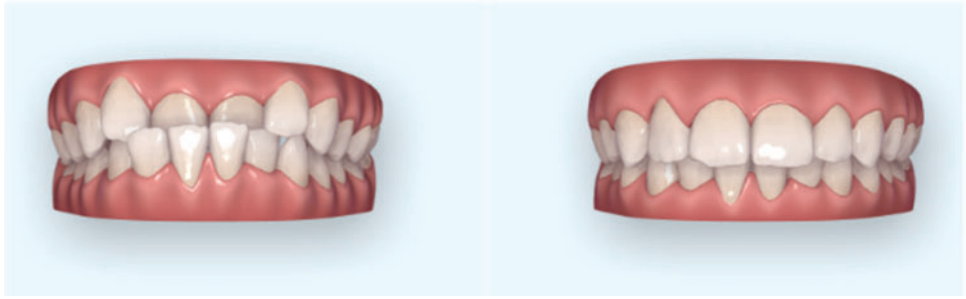
TABLE II: Cephalometric Analysis After 7 Years of Treatment with Reverse Headgear Face Mask

Measurements	Value	Norm
Horizontal Skeletal		
SNA º	76.3	82.0
SNB º	73.8	80.0
ANB º	2.5	2.0
Vertical Skeletal		
FMA (MP-PH) º	25.9	26
MP-SN º	38.1	33.0
Palatal-Mand Angle º	29.6	28.0
Palatal-Occ Plane º	8.8	10.0
Mand Plane to Occ Plane º	20.8	14.2
Mx occlusal plane (Mx OP-Na-Perp º	95.1	95.6
Anterior Dental		
U-Incisor protrusion (Ui-Apo) mm	9.4	6.0
L1 Protrusion (L1-Apo) mm	13.7	2.0
U1-Palatal Plane º	94.8	110.0
U1 Occ Plane º	76.4	54.0
L1 Occ Plane º	55.6	72.0
IMPA º	103.6	95.0

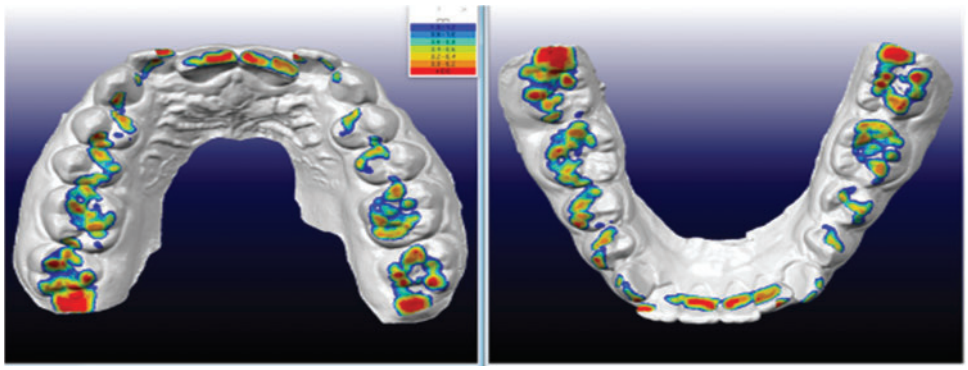
canine relationship with an overjet of 2 mm and an overbite of 3 mm, the center line was coincident with the buccal segment relationship showing a class I molar relationship on both sides (Fig. 11). The patient exhibited functional occlusion, there was a normal canine guide excursion, and there were no complications encountered during orthodontic treatment; McLaughlin analysis was used to evaluate the cephalometric confirmed Class I skeletal pattern (ANB 3.9°) with a retrognathic maxilla (SNA 79.2°), a slightly retrognathic mandibula (SNB 75.3°), upper incisors at 101.7° (UI/MX), lower incisors at 96° (IMPA), and an normal lower face height at 28° (palatal, mandibular plane) (Fig. 12; Table III). The overall superimposition before and after treatment revealed changes in the skeletal pattern from class III to class I and changes in the inclination of the upper and lower incisors from class III to class I. All permanent teeth are present (Fig. 13). Facial growth occurred, and the height of the lower face increased. (Fig. 14). A fixed lingual bonded retainer was placed in the lower arch from 33 to 43, and the upper aligner was used as a retainer. The patient's prognosis was good.

4. Discussion

For many years, reverse headgear has been used as a treatment for children with mixed dentition who present with class III malocclusions [19]. The protraction of the face mask used in this patient achieved successful treatment of the class III malocclusion with maxillary retrusion in the short-term prognosis [20]. This success was obtained with one degree of maxillary protraction, two degrees of mandibular retrusion and three degrees between both maxillaries as an effect of treating the slight downward and backward mandibular rotation [21], which occurs as a result of the balance between growth and treatment outcome [22] and is related to the forward and upward direction of condylar growth [23] of this patient, who exhibited regular growth rotation of the mandible. Additionally, there was pro-inclination of the upper incisors and retro-inclination of the lower incisors, which contributed to the dental alveolar compensation of the class III malocclusion. Although in the short term, the patient experienced a correction of the class III malocclusion, after seven years out of retention, the patient had a relapse that produced



(A)



(B)

Fig. 9. (A) Simulation of orthodontic treatment (B). Point contacts.

Fig. 10. Posttreatment photographs: extraoral.

Fig. 11. Posttreatment photographs: intraoral.

an anterior crossbite on a skeletal class I pattern. Nevertheless, tracing the lateral skull after seven years during his recall appointment revealed a value of 2.5° of ANB. The degree of ANB improved the skeletal pattern from class III to class I. In patients wearing a protraction face mask, relapse in terms of long-term prognosis may be influenced

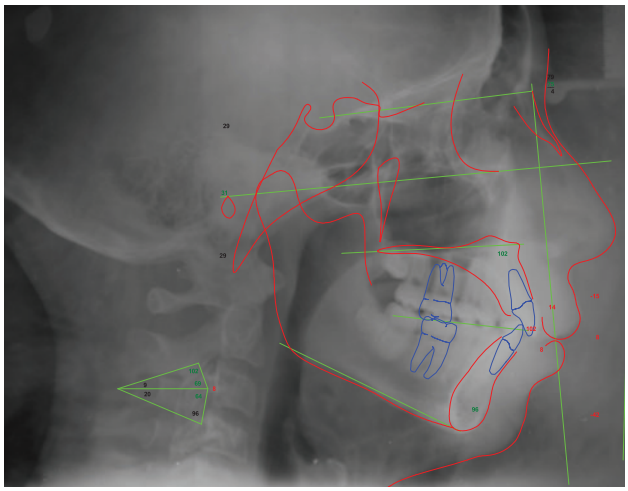


Fig. 12. McLaughlin cephalometric tracing confirmed the skeletal class I pattern with increased the height of the lower face and upper incisors at 102° and lower incisors at 96°.

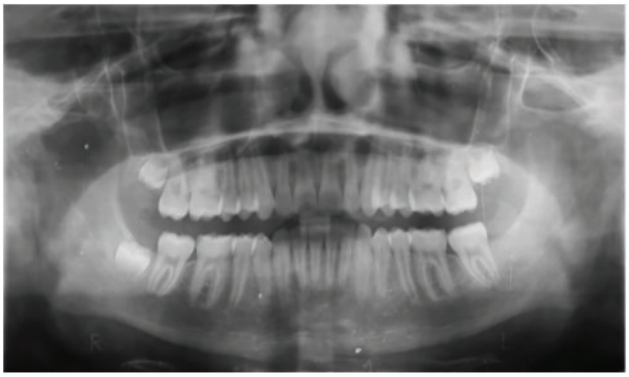


Fig. 13. After orthodontic treatment with aligners, a Panoramic view of the X-rays showed permanent dentition with no pathological features; Three third molars are present except for the lower left third molar.

by the difference in growth mechanisms between both maxillas when the maxillary protraction is eliminated and deciduous growth of the mandible continues, which causes relapse of the anteroposterior relationship [24]. Nevertheless, there was another opportunity to correct the anterior crossbite presented by the present patient by using fixed or removable appliances to avoid a surgical procedure. It is possible to treat crossbite patients who maintain a reasonable skeletal I pattern after reverse headgear treatment relapse, without extraction.

The patient asked for clear aligners for orthodontic treatment. Patients, especially those who are reluctant to wear fixed appliances, have been accepting clear aligners over the last two decades. The clear aligners are aesthetic, with less demineralization [25] and fewer periodontal problems [26]. The treatment of this patient with aligners to correct his anterior crossbite did not necessitate an upper expansion to allow buccal tipping of the upper incisors; the lower incisors were tipping lingually, as they were proinclined at 102° (IMPA). The cone beam tomography and scanning of the teeth were merged in the Invisalign platform, thereby allowing the calculation of the movement of the upper and lower incisors to be measured on the computer screen with a protractor to maximize the predictability of the movement and to reach the gold standard of the pre-adjusted fixed system of braces [27].

The patient was very keen to use the aligners, and he successfully wore 28 sets of aligners for at least 22 hours a day for six months, followed by six months of refinement aligners. A seven-day change protocol was adopted, which achieved good treatment results. Optimized attachments were placed according to the ClinCheck software, and

TABLE III: Cephalometric Tracing: (A) Before Treatment, (B) After 7 Years Out of Retention of the Reverse Headgear, (C) Posttreatment, (D) Norms

Measurements	Value			Norm
Horizontal skeletal	A	B	C	D
	Before treatment	After 7 years of reverse Face Mask	Post treatment with aligners	
SNA °	75.2	76.3	79.2	82.0
SNB °	76.1	73.8	75.3	80.0
ANB °	−0.9	2.5	3.9	2.0
Vertical				
FMA (MP-PH) °	25.4	25.9	31.3	26
MP-SN °	32.0	38.1	33.2	33.0
Palatal-Mand Angle °	26.8	29.6	28.9	28.0
Palatal-Occ Plane °	13.0	8.8	9.2	10.0
Mand Plane to Occ Plane °	13.8	20.8	19.2	14.2
Mx occlusal plane (Mx OP-Na-Perp °	101.6	95.1	101.6	95.6
Anterior Dental				
U-Incisor protrusion (Ui-Apo) mm	4.0	9.4	13.6	6.0
L1 Protrusion (L1-Apo) mm	7.6	13.7	8.1	2.0
U1-Palatal Plane °	99.8	94.8	101.7	110.0
U1 Occ Plane °	67.2	76.4	69.1	54.0
L1 Occ Plane °	62.7	55.6	64.3	72.0
IMPA °	103.5	103.6	96	95.0

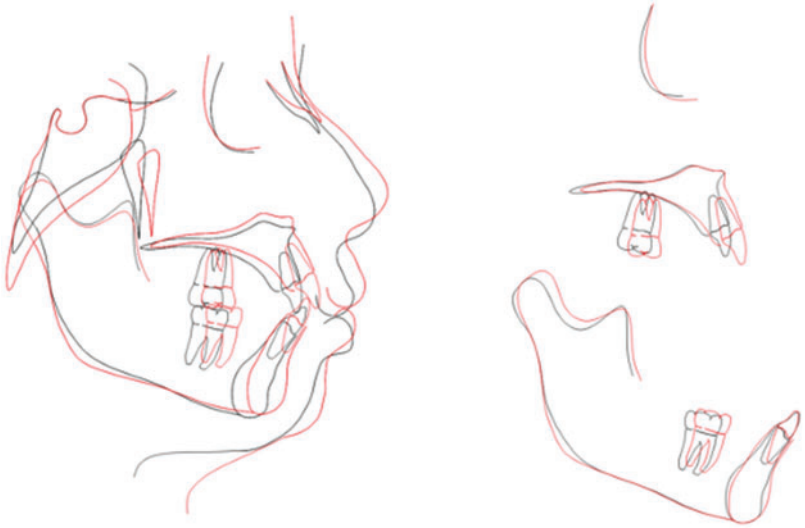


Fig. 14. Overall superimposition, registered on the sella-nasion line at the sella, black line: before treatment, red line: at the end of treatment.

interdental reduction was performed in the anterior labial segment to retro-cline the anterior lower teeth, achieving correction of the anterior crossbite [28].

5. Conclusions

Short treatment times and comfortable orthodontic treatment were provided by using clear aligners to correct a case of anterior crossbite that recurred after seven years out of retention post-treatment with a reverse headgear face mask.

Clear aligners can achieve functional and aesthetic results in correcting anterior crossbite if the patient cooperates well, which is the key to successful orthodontic treatment.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

References

[1] British Standards Institution. Glossary of Dental Terms (BS4492) BSI London. 1983. ISSN 058013184X, 9780580131844. https://search.worldcat.org/title/567637490.

[2] Cenzato N, Nobili A, Maspero C. Prevalence of dental malocclusions in different geographical areas: scoping review. *Dent J (Basel)*. 2021 Oct 11;9(10):117. doi: 10.3390/dj9100117. PMID: 34677179; PMCID: PMC8534899.

[3] Hardy DK, Cubas YP, Orellana MF. Prevalence of angle Class III malocclusion: a systematic review and meta-analysis. *Open J Epidemiol*. 2012;2:75–82.

[4] Kawala B, Antoszewska J, Necka A. Genetics or environment? A twin-method study of malocclusions. *World J Orthod*. 2007;8(4):405–10.

[5] Xue F, Wong RW, Rabie AB. Genes, genetics, and Class III malocclusion. *Orthod Craniofac Res*. 2010 May;13(2):69–74. doi: 10.1111/j.1601-6343.2010.01485.x. PMID: 20477965.

[6] Hopkin GB, Houston WJ, James GA. The cranial base as an aetiological factor in malocclusion. *Angle Orthod*. 1968 Jul;38(3):250–5. doi: 10.1043/00033219(1968)038<0250:TCBAAA>2.0.CO;2. PMID: 5242886.

[7] Guyer EC, Ellis EE 3rd, McNamara JA Jr, Behrents RG. Components of class III malocclusion in juveniles and adolescents. *Angle Orthod*. 1986 Jan;56(1):7–30. doi: 10.1043/0003-3219(1986)056<0007:COCIMI>2.0.CO;2. PMID: 3485393.

[8] Chen F, Terada K, Yang L, Saito I. Dental arch widths and mandibular-maxillary base widths in Class III malocclusions from ages 10 to 14. *Am J Orthod Dentofacial Orthop*. 2008 Jan;133(1):65–9. doi: 10.1016/j.ajodo.2006.01.045. PMID: 18174073.

[9] Lin J. Creative orthodontics. In *Blending the Damon System & TADs to Manage Difficult Malocclusions*. Taiwan, Yong: Chieh Co. January 2023. ISBN:978-986-83331-1-6.

[10] Yang X, Li C, Bai D, Su N, Chen T, Xu Y, *et al.* Treatment effectiveness of Fränkel function regulator on the Class III malocclusion: a systematic review and meta-analysis. *Am J Orthod Dentofacial Orthop*. 2014 Aug;146(2):143–54. doi: 10.1016/j.ajodo.2014.04.017. PMID: 25085296.

[11] McNamara JA Jr. An orthopedic approach to the treatment of Class III malocclusion in young patients. J Clin Orthod. 1987 Sep;21(9):598-608. *Erratum: J Clin Orthod*. 1987 Sep;21(9):804. PMID: 3328750.

[12] Sugawara J, Mitani H. Facial growth of skeletal Class III malocclusion and the effects, limitations, and long-term dentofacial adaptations to chincap therapy. *Semin Orthod*. 1997 Dec;3(4):244–54. doi: 10.1016/s1073-8746(97)80057-6.

[13] De Clerck H, Cevidanes L, Baccetti T. Dentofacial effects of bone-anchored maxillary protraction: a controlled study of consecutively treated Class III patients. *Am J Orthod Dentofacial Orthop*. 2010 Nov;138(5):577–81. doi: 10.1016/j.ajodo.2009.10.037. PMID: 21055597; PMCID: PMC3033914.

[14] Woon SC, Thiruvenkatachari B. Early orthodontic treatment for Class III malocclusion: a systematic review and meta-analysis. *Am J Orthod Dentofacial Orthop*. 2017 Jan;151(1):28–52. doi: 10.1016/j.ajodo.2016.07.017. PMID: 28024779.

[15] Hagg U, Tse A, Bendeus M, *et al.* Long-term follow-up of early treatment with reverse headgear. *Eur J Orthod*. 2003;25:95–102.

[16] Mandall N, Cousley R, DiBiase A, Dyer F, Littlewood S, Mattick R, *et al.* Early class III protraction facemask treatment reduces the need for orthognathic surgery: a multi-centre, two-arm parallel randomized, controlled trial. *J Orthod*. 2016 Sep;43(3):164–75. doi: 10.1080/14653125.2016.1201302. PMID: 27564126; PMCID: PMC5062052.

[17] Wells AP, Sarver DM, Proffit WR. Long-term efficacy of reverse pull headgear therapy. *Angle Orthod*. 2006 Nov;76(6):915–22. doi: 10.2319/091605-328. PMID: 17090164.

[18] Ruellas AC, Baratieri C, Roma MB, Izquierdo Ade M, Boaventura L, Rodrigues CS, *et al.* Angle Class III malocclusion treated with mandibular first molar extractions. *Am J Orthod Dentofacial Orthop*. 2012 Sep;142(3):384–92. doi: 10.1016/j.ajodo.2011.01.025. PMID: 22920705.

[19] Delaire J, Verdon P. L'emploi des forces extraorales postéro-antérieures lourdes sur masque orthopédique dans le traitement des séquelles dento-maxillaires des fentes labio-maxillo-palatines [The use of heavy postero-anterior extraoral forces by an orthopedic

mask in the treatment of dentomaxillary sequellae of labiomaxillopalatal clefts]. *Chir Pediatr*. 1983;24(4-5):315–22. French. PMID: 6652845.
[20] Cozza P, Marino A, Mucedero M. An orthopaedic approach to the treatment of Class III malocclusions in the early mixed dentition. *Eur J Orthod*. 2004 Apr;26(2):191–9. doi: 10.1093/ejo/26.2.191. PMID: 15130043.
[21] Anne Mandall N, Cousley R, DiBiase A, Dyer F, Littlewood S, Mattick R, *et al.* Is early Class III protraction facemask treatment effective? A multicentre, randomized, controlled trial: 3-year follow-up. *J Orthod*. 2012 Sep;39(3):176–85. doi: 10.1179/1465312512Z.00000000028. PMID: 22984102.
[22] Xu S, Liu Y, Hou Y, Li Y, Ge X, Wang L, *et al.* Maxillofacial growth changes after maxillary protraction therapy in children with class III malocclusion: a dual control group retrospective study. *BMC Oral Health*. 2024;24:7. doi: 10.1186/s12903-023-03790-6.
[23] Franchi L, Pavoni C, Cerroni S, Cozza P. Thin-plate spline analysis of mandibular morphological changes induced by early class III treatment: a long-term evaluation. *Eur J Orthod*. 2014;36(4):425–30. doi: 10.1093/ejo/cjt067.
[24] Lin Y, Guo R, Hou L, Fu Z, Li W. Stability of maxillary protraction therapy in children with Class III malocclusion: a systematic review and meta-analysis. *Clin Oral Investig*. 2018;22(7):2639–52. doi: 10.1007/s00784-018-2363-8.
[25] Albhaisi Z, Al-Khateeb SN, Abu Alhaija ES. Enamel demineralization during clear aligner orthodontic treatment compared with fixed appliance therapy, evaluated with quantitative light-induced fluorescence: a randomized clinical trial. *Am J Orthod Dentofacial Orthop*. 2020 May;157(5):594–601. doi: 10.1016/j.ajodo.2020.01.004. PMID: 32354432.
[26] Han JY. A comparative study of combined periodontal and orthodontic treatment with fixed appliances and clear aligners in patients with periodontitis. *J Periodontal Implant Sci*. 2015;45:193–204. doi: 10.5051/jpis.2015.45.6.193.
[27] Bennett JC, McLaughlin RP. Fundamentals of orthodontic treatment mechanics. *Eur J Orthod*. 2015 Apr;37(2):230–1. Book Review. London, UK and Dubai: Le Grande Publishing, pp. 289. ISBN: 978-0-9564555-2-9. doi: 10.1093/ejo/cju072.
[28] Wiedel AP, Bondemark L. Fixed versus removable orthodontic appliances to correct anterior crossbite in the mixed dentition: a randomized controlled trial. *Eur J Orthod*. 2015;37(2):123–7.