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Prediction of the individual response to treatment of skeletal Class III malocclusions and their long-term stability. A Case Report.

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Key words: Class III; facial mask; craniofacial growth.

Abstract. Predicting the outcome of the treatment and its stability over time is an invaluable tool for the clinician when initiating therapy for correction of class III skeletal malocclusions. This work reports the predicted response to treatment of a 5-year-old female patient with skeletal Class III malocclusion and its long-term stability. The individual prediction cephalometric model of Baccetti and Franchi was applied in this case. As a result of the predictive equation, an individual value of -0.958 was obtained (norm = -0.4065), which predicted a "very good response to treatment". The Class III malocclusion and anterior crossbite were corrected, and the profile was harmonized with rapid maxillary expansion (RME) and a facemask projecting the maxilla forward 12 mm, in addition to the mandible's 9° total downward rotation. After 15 years and three months of completing the treatment, the stability of the results was confirmed. In conclusion, the individual prediction cephalometric model used in this case report allowed us to accurately predict the results in facial, skeletal and dental changes and the long-term stability of the treatment of class III skeletal malocclusion.

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Predicción de la respuesta al tratamiento de las maloclusiones clase III esqueléticas y su estabilidad a largo plazo. Presentación de un caso.

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Palabras clave: Clase III; máscara facial; crecimiento craneofacial.

Resumen. Predecir el resultado del tratamiento y su estabilidad en el tiempo es una herramienta invaluable para el clínico al iniciar una terapia para la corrección de las maloclusiones esqueléticas clase III. Este trabajo reporta los hallazgos de la predicción de la respuesta al tratamiento y su estabilidad a largo plazo en una paciente femenina de 5 años de edad con maloclusión Clase III esquelética. Se aplicó el modelo cefalométrico de predicción individual de Baccetti y Franchi y se obtuvo como resultado de la ecuación predictiva un valor individual de -0.958 (norma= -0.4065), lo cual predijo una "*muy buena respuesta al tratamiento*". Se corrigió la maloclusión Clase III, la mordida cruzada anterior y se armonizó el perfil con expansión rápida maxilar (ERM) y una máscara facial mediante la proyección de la maxila 12 mm hacia adelante, además de la rotación descendente total de la mandíbula 9°. Después de 15 años y 3 meses de finalizado el tratamiento se confirmó la estabilidad de los resultados. En conclusión, el modelo cefalométrico de predicción individual utilizado en este reporte de caso permitió predecir de manera acertada los resultados en los cambios faciales, esqueletales y dentales y la estabilidad a largo plazo del tratamiento de la maloclusión esquelética clase III.

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INTRODUCTION

Class III skeletal malocclusion, due to its characteristics, gives a hard aspect and the appearance of a severe and rigid person. In fact, in comics, bad guys are attributed a profile of this type. However, these malocclusions are generally easy to diagnose and treat in growth-development patients. It is common for parents to notice them by their appearance alone; that is, class III is evident and is also friendly in its therapeutic response in most cases [1].

They can present with alterations in various structures [2]. however, relapse is a phenomenon that develops frequently. To be considered a successful therapy, good results need to be maintained in the long term. The response to treatment and its stability vary from patient to patient, so some patients are predestined to orthopedic failure and surgical treatment in adulthood [3-5].

The facemask is one of the most effective orthopedic therapies. However, failure can occur even in correctly applied treatments and with cooperative patients in some cases, generating frustration in the patient and the clinician [6]. This context places the dentist at a disadvantage; there is a need to know when to start the treatment, which cases will be corrected successfully and which will not, the conditions that determine good results, and their long-term stability. Saadia M. affirms that if the therapy is applied

when the biological events occur during the growth and craniofacial development process (during the primary and early mixed dentitions), it will have a more effective impact and have less tendency to relapse[7]. The authors Zere *et al.* and Campbell state that applying these treatments in the prepubertal stage is necessary [8,9]. Tweed described two different patterns of Class III malocclusion that predict the outcome of the treatment: a favorable pattern characterized by hypodivergent growth and an unfavorable pattern characterized by hyperdivergent growth [10]. Wendl *et al.* analyzed differences between patients with Class III malocclusion treated with success or failure, finding that an increased maxillary intermolar width has a higher risk of recurrence and treatment failure [11]. Paoloni *et al.* report that the width of the dental arch and the length of the upper sagittal arch in primary dentition are predictors of prognosis; when the length of the arch is decreased and the intermolar dimension is increased, there will be a greater risk of recurrence [12]. Thamira *et al.* and Zentner *et al.* reported that the gonial angle, ramus dimensions, and the mandibular body were determining factors between those who responded well or poorly to Class III treatment. The treatments were done with commonly used fixed and removable devices and combinations. An evaluation of the retention of the results was not provided [13,14]. Björk reports that a closed angulation of the skull base in patients with class III malocclusion is an unfavorable condition in the prognosis of long-term treatment [15].

Some cephalometric indicators predict treatment prognosis based on different variables, achieving different confidence levels. The most frequently studied variables are the gonial angle, Witts assessment, ramus length, the inclination of the lower incisors with respect to the mandibular plane, and the SNB angle [11,16].

Baccetti and Franchi proposed a model of cephalometric variables that individually predicts the response to treatment of skeletal Class III malocclusions treated with rapid maxillary expansion (RME) and facemask[17]. This predictive model is based on three cephalometric measurements: the vertical length of the mandibular ramus (Co-Go), the skull base angle (Ba-T and SBL), and the angle of the mandibular plane and cranial base (PM-SBL). When applying the results of these cephalometric measurements to an equation generated with the multivariate statistical method at the beginning of treatment, an individual value is obtained, which, when compared to the established norm (-0.4065), can predict the degree of therapeutic success or failure [17] (Fig. 1).

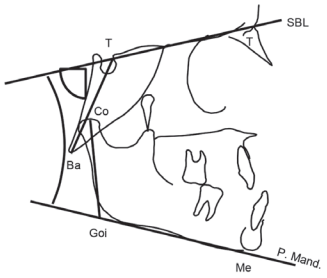
The present work describes the findings of the prediction of the response to treatment with rapid expansion and facial mask of a skeletal Class III malocclusion and its long-term stability using the Baccetti and Franchi predictive method [17].

CASE PRESENTATION

This is the case report of a 5-year-old female patient who attended the orthodontic service at the Piezzo Clinic in Zacatecas, Mexico. After explaining the study's purpose, her parents signed a consent form and approved the publication of her photographs in this paper.

The patient presented no medical history of interest, with an euryprosopic, symmetrical, and levelled facial type. She had a slightly decreased lower third, concave profile with an evident anteroposterior deficiency in the middle third and an increased chin-neck distance (Fig. 2a). The patient had primary dentition with the absence of dental organ 51, physiological spaces present, a -6mm severe anterior crossbite, bilateral edge-to-edge posterior occlusion, exaggerated or severe mesial step, bilateral class III canine relationship, and 0% overbite. (Fig. 3a).

The cephalometric analysis [18] revealed a concave skeletal Class III profile with maxillary retroposition and mandibular upward rotation (Fig. 4a).



T	Tuberculum Sellae
SBL	Stable Basicranial Line
Co	Condylion
Ba	Basion
Goi	Gonion Intersection
Me	Menton
P. Mand.	Mandibular plane

Coefficients		
(Co-Goi	x	0.2282)
+ (Ba-T-SBL	x	0.205)
+ (Mand P. –SBL	x	0.120)
-*Constant*		- 29.784
= Individual Value		"X"
Norm Critical Value		-0.4065

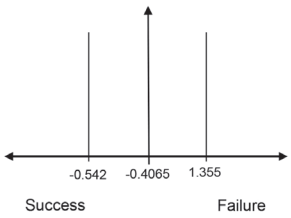


Fig. 1. (Procedure): Cephalometric Measurements of the predictive model of Baccetti and Franchi, and predictive model equation and critical value.

Fig. 2. Front and profile photographs: Initial, five years-seven months old (2a), four months after starting maxillary protraction, five years 11 months old (2b), end of orthopedic treatment, nine years 11 months old age (2c), facial characteristics 15 years three months post-treatment, 25 years two months old (2d).

When calculating the predictive value of the Baccetti and Franchi model for Class III, the result was –0.958. According to this indicator, the patient would have "a great response" to the treatment [17] (Fig. 5).

The patient was treated with rapid maxillary expansion (RME) using a fixed Hyrax-type expander for three weeks, with daily activation, and maxillary protraction therapy with a facemask, starting at cervi-

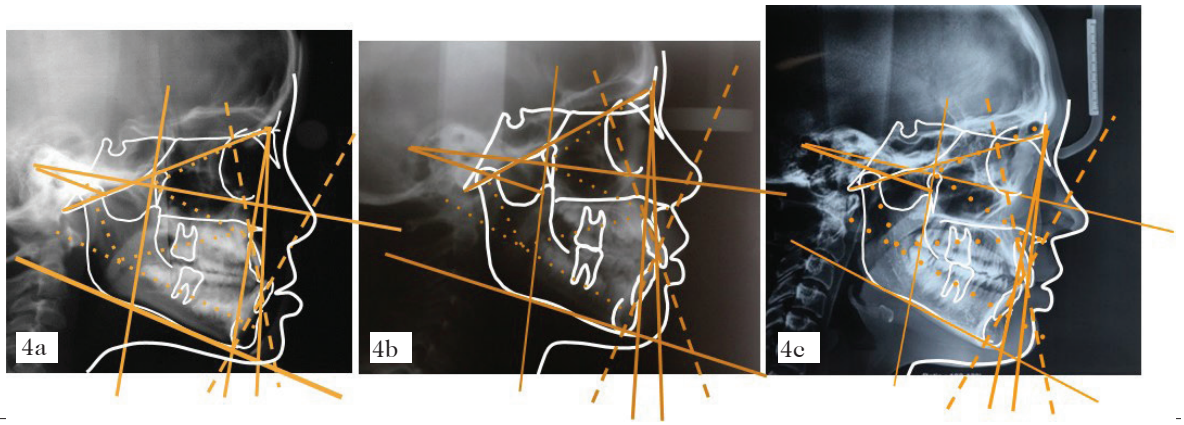
Fig. 3. Intraoral photographs: Initial, five years seven months of age (3a), four months after beginning maxillary protraction, five years 11 months of age (3b), end of orthopedic treatment, nine years 11 months of age (3c), occlusal characteristics, 15 years three months post-treatment, 25 years two months old (3d).

cal maturation stage SC1 [19], at five years and seven months of age, with constant use of 16 hours a day for a year, positive results were manifested from the first four months (Figs. 2b and 3b). She then continued using the facemask occasionally for periods of three months, with a break of approximately eight months to control relapse until the end of the maxillary growth peak, cervical maturation stage SC3 [19] and ending at nine years 11 months, with a total treatment time of four years and four months. A straight, harmonious, and proportionate profile was obtained (Fig. 2c), achieving a bilateral Class I molar and canine relationship and a positive overbite of 2 mm (Fig. 3c).

The post-treatment cephalometry [18] quantified the improvement in the characteristics of the skeletal profile. The most notable being the 9° forward relocation of the maxilla, as well as the relocation of the chin backward, due to the sum of the downward rotations between ramus and body, 4° the mandibular arch, and 9° the mandibular plane. At the end of this orthopedic phase, the patient was nine years and 11 months old (Figs. 2c, 3c, and 4b). The parents were satisfied with this result and decided not to proceed with a second multibracket phase for the final correcting details.

New records were taken when the patient was 25 years old. A symmetrical face was observed with properly proportioned thirds, a harmonious contour, and a straight and balanced profile (Fig. 2d). Intraorally, the overjet and overbite remained stable. Likewise, in an anteroposterior direction, the class I molar relationship and the bilateral class I canine relationship achieved at the end of treatment were maintained without recurrence up to the end of the follow-up period. The anterior lower spaces were maintained, while the upper ones were closed (Fig. 3d).

In cephalometry [18], relevant changes were the increases in maxillary height and AFAI that combined with a stable maxillary depth (91°) and the increase in the measurement of the mandibular arch (4°) in the 15 years after completing the treatment (Fig. 4c). They further improved the balance and



Cephalometric Measurement	Norma / Patient pretreatment (4a)	Norma / Patient Ends of orthopedic (4b)	Norma / Patient 15.3 years posttreatment(4c)
Convexity	2mm/ -7mm	2mm/ 5mm	2mm/3mm
Maxillary depth	90° / 83°	90° / 92°	90° / 91°
Facial depth	87° / 89°	87° / 86°	87° / 88°
Mandibular body length	61mm / 60 mm	65mm / 64 mm	69 / 70 mm
Mandibular plane	26° / 19°	26° / 28°	26° / 27°
Maxillary height	51° / 44°	53° / 54°	57° / 58°
Lower Anterior Facial Height (LAFH)	47° / 41°	47° / 48°	47° / 50°
1 upper/ N-A	22° / 21°	22° / 23°	22° / 23 °
1 lower / N-B	25° / 24°	25° / 25°	25° / 25°
Mandibular arch	26° / 31°	26° / 27°	28.5° / 31°
Cranial deflection	27°/ 24°	27°/ 24°	27°/ 24°
Posterior facial height	55mm/ 51mm	56.4mm/ 54mm	58.5mm/ 57mm

Fig. 4. Cephalometric analysis: Initial at five years seven months of age (4a). End phase 1, at nine years 11 months of age (4b). Measurements at 25 years two months of age (4c).

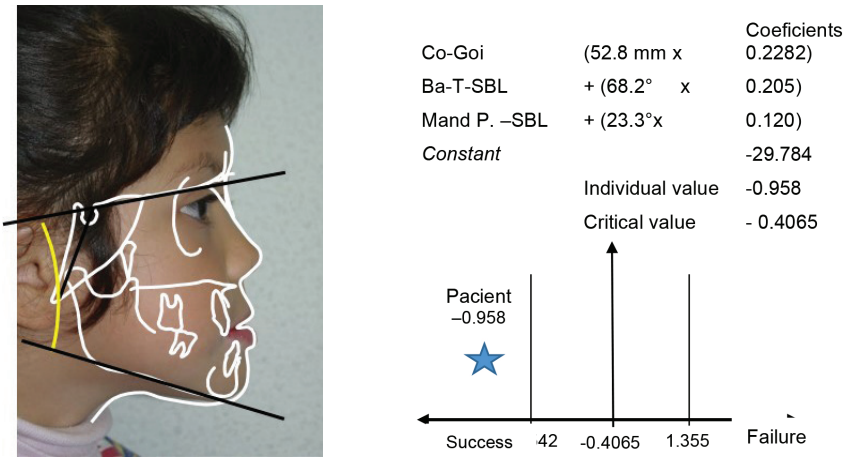


Fig. 5. Application of the individual prediction model at the beginning of treatment. According to this result, it would have a great response and stability.

symmetry in the profile and the lower third, adjusting with the self-consolidation of the permanent dentition (Fig. 3d).

DISCUSSION

Skeletal Class III treatments in children are very rewarding because they are imposing on most patients. However, there are some cases that, due to their characteristics, require surgical treatment when they reach adulthood [1].

The Baccetti and Franchi cephalometric prediction model for Class III identifies three variables with a predictive power of 83.3% reliability [17]. Orthopedic treatment will be unfavorable when there is: a) an acute angle of the skull base (Ba- T and the SBL), b) an open angle between the mandibular plane and the cranial base (PM-SBL), and c) a long mandibular ramus (Co-Goi) [17], (Fig. 1). It is worth mentioning that these authors only included the stability results after a follow-up of six years post-treatment. In the present case report, this model correctly predicted the favorable response to treatment after 15 years.

In skeletal Class III, the therapeutic solution is based mainly on the anterior repositioning of the maxilla and downward mandibular rotation, thus increasing the anterior inferior facial height (AFAI) [4]. Westwood *et al.* states that all orthopedic force is more effective when applied in the same direction of displacement due to bone growth [6]. By nature, the direction of displacement during the growth of the upper jaw is forward and downward (perpendicular to the anterior cranial base) [20]. So, if the anterior cranial base presents an inclination upwards (open skull base angle), we will have a better response to the orthopedic maxillary protraction. Furthermore, if the mandible has a counterclockwise rotation (closed mandibular plane angle) and a vertically short ramus, there will be a better response to the effect of the facial mask, thus obtaining a straighter profile and a more proportionate and balanced face and vice versa [6]. These considerations give meaning to the cephalometric measurements of the predictive model of Baccetti and Franchi since they evaluate precisely these variables. In addition, they include structures governed by genetics, such as the skull base, and others that can be modified by the environment, such as the maxilla and mandible [21], which makes it more systematic and distinguishes it from the others. This statement coincides with that of Batagel [2] and Björk [15], who report that a closed angulation of the skull base is an unfavorable condition in the prognosis of long-term treatment. The patient presented an open cranial base angulation in this report.

The other two variables analyzed by this prediction model are the vertical length of the ramus and the mandibular rotation through the distance from Co to Goi and the angle between the mandibular plane (PM) and the skull base (SBL), respectively. A short vertical ramus and a decreased mandibular plane angle may indicate a lack of vertical growth in the middle and lower third of the face [18]. So, if these measurements within the predictive equation result in a figure below the critical value or norm, it will be reasonable that the response is good since protraction therapy will cause downward rotation of the jaw, increasing the vertical and generating a straighter profile and a better proportion in the dimensions of the face.

Tweed and Nardoni *et al.* report that the hypo-divergent facial growth pattern predicts success, and the hyper-divergent pattern predicts treatment failure [10,16]. This conclusion is reasonable since one of the effects generated by the biomechanics of facial mask therapy is the downward rotation of the jaw, thus increasing the facial vertical. The patient presented in this work had a hypo-divergent facial pattern. The importance of vertical skeletal relationships in determining the prognosis of early treatment of Class III malocclusions has also been emphasized by Franchi *et al.* [22], who found that patients

with a large angle between the mandibular and palatal planes in the primary dentition ended up with less favorable long-term results. Tahmina *et al*. and Zentner *et al*. agree with this predictive cephalometric model regarding the height of the mandibular ramus since they also identified the height of the ramus and the dimensions of the mandibular body as discriminating factors between those who responded well or poorly to the treatment [13,14]. The patient in this report had decreased posterior facial height and a vertically short ramus.

Some research has reported other types of predictive variables based on the dimensions of the dental arches. Paoloni *et al*. and Franchi *et al*. report that the width of the dental arch and the length of the upper sagittal arch in primary dentition are predictors of prognosis. When the arch length decreases and the inter-molar dimension increases, there will be a greater risk of recurrence [12,22]. In the present case, the patient had primary dentition at the beginning of the treatment; the transverse dimension of the upper arch was decreased, with an adequate arch length. Hence, the excellent treatment results and long-term stability coincided with the findings of these authors [12,22]. In the present case, the structural characteristics were corrected with the treatment and generated self-improvement and stability of long-term results, which was considered a successful treatment. Surprisingly, in this patient, 15 years and three months after treatment, her clinical and cephalometric records still showed specific favorable self-regulated changes, which allows us to think that in some skeletal Class III malocclusions, craniofacial growth and development are capable of improving on its own. Their conditions exceeded our expectations.

In conclusion, the individual prediction cephalometric model of the authors Baccetti and Franchi for Class III malocclusion, applied in the present report, predicted the success of the treatment of this particular patient and could be confirmed not only with the results in the facial-skeletal and dental changes but also with its long-term stability within the 15 years post-treatment follow-up.

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Conflicts of interest

The authors reported no potential conflict of interest.

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Authors' contribution

SD: Treatment and clinical and radiographic follow-up of the case. Conception, design, analysis, and interpretation of data, editing, review, and approval of the final version of the manuscript to be published. Funding support. AD: Analysis and interpretation of data, editing, review, and approval of the final version to be published. OZ: Conception, design, analysis, and interpretation of data, editing, critical review, and approval of the final version to be published. JL: Analysis and interpretation of data, critical review, and approval of the final version to be published.

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