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Comparison of compensatory class III malocclusion treatment changes with two prescriptions of preadjusted brackets

Comparação das alterações do tratamento compensatório da má-oclusão de Classe III com duas prescrições de bráquetes preajustados

Domingos Vieira[1], Paula Cotrin[2*], Christian Zamberlan Angheben[3], Karina Maria Salvatore de Freitas[4], Rodrigo Hermont Cançado[5], Fabrício Pinelli Valarelli[6]

[1]Graduado em Odontologia, Universidade de Marília – UNIMAR, Mestre em Odontologia, Centro Universitário Ingá – Uninga; [2]Graduada em Odontologia, Universidade Paranaense – UNIPAR, Mestre pelo Programa de Mestrado Profissionalizante em Ortodontia, Centro Universitário Ingá – UNINGA, Doutora em Ciências Odontológicas Aplicadas, Faculdade de Odontologia de Bauru, Universidade de São Paulo – USP, Professora do Curso de Mestrado Profissionalizante em Ortodontia, Centro Universitário Ingá – UNINGA; *[3]Graduado em Odontologia, Universidade Federal do Rio Grande do Sul – UFRGS, Mestre em Ortodontia, Centro Universitário Ingá – UNINGA, Doutorado em Medicina: Ciências Médicas, Universidade Federal do Rio Grande do Sul –UFRGS, Coordenador da Pós-Graduação em Ortodontia da Faculdade de Educação Superior Chapecó – FACESC*; *[4]Graduada em Odontologia, Universidade de São Paulo – USP, Mestre em Ortodontia e Odontologia em Saúde Coletiva, Universidade de São Paulo – USP, Doutora em Ortodontia e Odontologia em Saúde Coletiva, Universidade de São Paulo – USP, Docente e Coordenadora do Mestrado Profissionalizante em Odontologia do Centro Universitário Ingá – UNINGÁ*; *[5]Graduado em Odontologia, Faculdade de Odontologia de Bauru Universidade de São Paulo – FOB/USP, Mestre em Ortodontia – FOB/USP, Doutor em Ortodontia – FOB/USP, Professor Adjunto C, Nível 1 de Ortodontia do Departamento de Odontologia Restauradora da Faculdade de Odontologia da Universidade Federal de Minas Gerais – UFMG*; *[6]Graduado em Odontologia, Universidade de São Paulo – USP, Mestre em Ortodontia, Universidade de São Paulo – USP, Doutor em Ortodontia e Odontologia em Saúde Coletiva, Universidade de São Paulo – USP, Professor Adjunto do Centro Universitário Ingá UNINGÁ*

Abstract

Objective: *this retrospective study compared Class III malocclusion treatment changes performed with two preadjusted bracket prescriptions: Biofunctional and Roth.* ***Methodology:*** *the sample comprised 84 Class III malocclusion patients treated with compensatory approaches. The sample was divided into two groups: Group 1 (Biofunctional): 36 patients (23 female, 13 male) with a mean initial age of 20.04 years and a mean treatment time of 2.53 years. Group 2 (Roth): 48 patients (28 female and 20 male) with a mean initial age of 19.05 years and a mean treatment time of 2.64 years. Intergroup comparisons at the pre- (T1) and posttreatment (T2) stages and of the treatment changes (T2-T1) were performed with t-tests.* ***Results:*** *there were greater maxillary and mandibular incisors, labial and lingual tipping and greater occlusal plane counterclockwise rotation in the Roth than in the Biofunctional prescription.* ***Conclusion:*** *compensatory Class III malocclusion treatment performed with the Biofunctional prescription minimizes the side effects of Class III elastics.*

Keywords*: Malocclusion Class III Angle; nonsurgical treatment; comparative study.*

Resumo

Objetivo: *este estudo retrospectivo teve como objetivo comparar as alterações do tratamento da má-oclusão de Classe III com duas prescrições diferentes de bráquetes preajustados: Biofuncional e Roth.* **Metodologia:** *a amostra consistiu em 84 pacientes com má-oclusão de Classe III tratados com abordagens compensatórias. A amostra foi dividida em 2 grupos: Grupo 1 (Biofuncional): 36 pacientes (23 mulheres, 13 homens) com idade inicial média de 20,04 anos e um tempo médio de tratamento de 2,53 anos. Grupo 2 (Roth): 48 pacientes (28 mulheres e 20 homens) com idade inicial média de 19,05 anos e um tempo médio de tratamento de 2,64 anos. As comparações intergrupo ao início (T1) e ao fim do tratamento (T2) e as alterações do tratamento (T2-T1) foram feitas com testes t.* **Resultados:** *houve uma maior vestibularização dos incisivos superiores e inferiores, retroclinação dos incisivos inferiores e uma maior rotação anti-horária do plano oclusal na prescrição Roth do que na Biofuncional.* **Conclusão:** *o tratamento compensatório da má-oclusão de Classe III feito com a prescrição Biofuncional minimiza os efeitos colaterais do elástico de Classe III.*

Palavras-chave*: Má-oclusao de Classe III de Angle; tratamento não-cirurgico; estudo comparativo.*

INTRODUCTION

Class III malocclusion has an average incidence of 5.5% in the population[1], and its treatment is challenging

Corresponding/Correspondente: *Paula Cotrin – Rod. PR 317, 6114 Parque Industrial 200, Maringá – PR, 87035-510, Brazil – Phone Number: 55-44-99947-4498 – Email: cotrin@hotmail.com

for orthodontists[2,3]. With the advent of preadjusted brackets, some specific prescriptions have been developed that could assist in Class III malocclusion treatment[4-6].

Very often, facial esthetics in Class III malocclusion patients become unpleasant due to the increase in mandibular growth and can become a psychosocial problem[3]. Many patients who did not receive early orthodontic treatment seek it in the permanent dentition[7]. Therapy of skeletal Class III malocclusion in adults can be performed by orthodontic camouflage or surgical-orthodontically[8].

In most cases, surgical-orthodontic treatment promotes a better esthetic result by correcting the skeletal discrepancies that cause facial disharmony[9,10]. However, in less severe discrepancies or for those patients who do not want to undergo orthognathic surgery, an alternative to the surgical approach is the orthodontic camouflage by means of dentoalveolar compensations, which can also present satisfactory results[11-13]. Furthermore, it is always necessary to evaluate the limitations of this procedure, avoiding undesirable sequels for teeth, periodontium and patient profile[14].

The most common way to treat Class III malocclusion with dentoalveolar compensation is using intermaxillary elastics. However, using elastics may produce unfavourable incisor inclination, which can harm adjacent teeth and structures and may negatively affect the patient's smile[11,14].

One of the great concerns about Class III orthodontic camouflage is the mandibular incisors' final position. While some authors rely on maintenance or exacerbation of the naturally lingual position of the mandibular incisors[5,6], others[4,11,15] state that labial crown torque would be needed to improve their position and resist the effects generated by the intermaxillary elastics mechanics.

Since there are several preset bracket prescriptions to correct Class III malocclusion with varying torques in the incisors, it is speculated that the final position of these teeth may be different according to the bracket prescription used during treatment[4,11].

Unlike other prescriptions[16], the Biofunctional prescription presents labial crown torque in the mandibular incisors and zero torque in the maxillary incisors. This is very important in compensatory Class III malocclusion treatment. The side effects of Class III elastics (proclination of maxillary incisors and retroclination of mandibular incisors) are counteracted. This leads to better finishing, produces greater alveolar bone remodelling and places the mandibular incisors in a more adequate position in the alveolar ridge [4,11,13,17].

Based on the aforementioned speculations, this study aimed to compare the incisor and molar inclinations in Class III malocclusion treatment with two prescriptions of preadjusted brackets.

MATERIAL AND METHODS

Material

This retrospective study was approved by the Ethics in Human Research Committee at Inga University Center, under number 0193.0.362.10.

Sample size calculation was performed based on an alpha significance level of 5% and a beta of 20% to detect a minimum difference of 3° with a standard deviation of 4.5° for the mandibular incisor inclination[17,18]. Thus, the sample size calculation resulted in the need for 36 patients in each group.

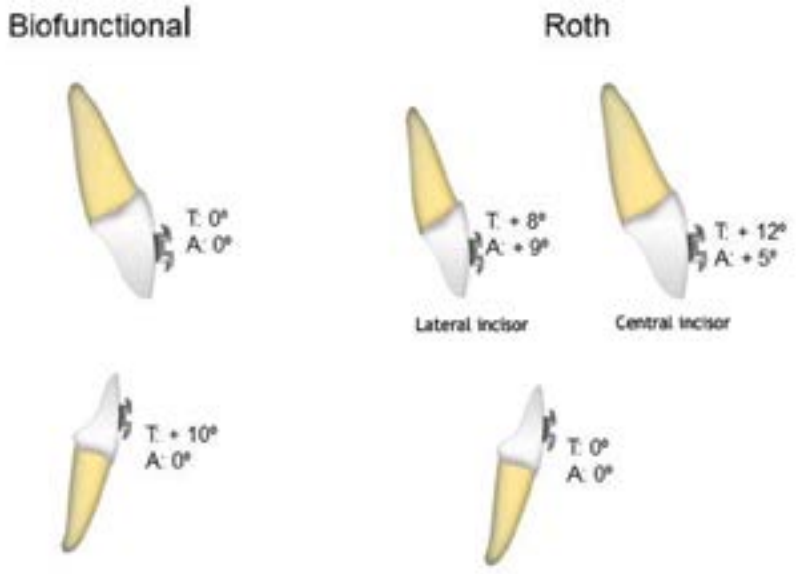
Data were collected according to the following inclusion criteria: Class III malocclusion with at least ¼ Class III molar relationship[19-21]. Effectiveness of early treatment of Class II malocclusion. Complete permanent dentition including erupted first permanent molars at the beginning of treatment, no dental agenesis, no tooth form abnormality, no previous orthodontic treatment, camouflage treatment performed with Class III elastics and without dental extractions, complete orthodontic records at two stages: pre and posttreatment. Additionally, at the end of treatment, molars and canines should be in Class I relationship with a satisfactory occlusion.

The sample was obtained from the Orthodontic Files of XXX and divided into two groups according to the bracket prescription, as follows:

Group 1: 36 patients (23 female, 13 male) whose treatments were performed with Biofunctional prescription brackets (Morelli®, Sorocaba, SP Brazil). The mean pretreatment and posttreatment ages were 20.04±8.04 and 22.58±8.13 years, respectively. The mean treatment time was 2.53±0.84 years. This bracket prescription has zero torque and angulation for the maxillary incisors and + 10° torque and zero angulation for the mandibular incisors (Fig. 1).

Group 2: 48 patients (28 female, 20 male) whose treatments were performed with Roth prescription brackets (Morelli®, Sorocaba, SP Brazil). The mean pretreatment and posttreatment ages were 19.05±8.46 and 22.10±8.57 years, respectively. The mean treatment time was 2.64±0.99 years. This bracket prescription has +12° torque and +5º angulations for the maxillary central incisors and +8° torque and +9º angulations for the maxillary lateral incisors. The mandibular incisors have zero torque and zero angulation (Fig. 1).

Figure 1- *Basic differences between Biofunctional and Roth prescriptions (T: Torque; A: Angulation)*



METHODOLOGY

In the pretreatment dental casts, mandibular anterior crowding was measured with the Little Irregularity index[21,22]. All dental cast measurements were performed with a 0.01 mm precision digital caliper (Mitutoyo America, Aurora, Ill) by the first author (FPV). The author's calibration took place with the repetition of several sequences of measurements.

The molar relationship in the pretreatment dental casts evaluated the malocclusion severity. It was classified as ¼, ½, ¾ and full cusp Class III relationships.

The cephalograms were digitized with a Microtek Scanmaker i800 scanner (Microtek International, Inc., Carson, CA, USA) and the cephalometric measurements were performed with Dolphin Imaging Premium 10.5 software (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). The first author (FPV) directly marked the cephalometric landmarks on the computer. The author's calibration took place with the repetition of several sequences of direct marking of the cephalometric landmarks. The cephalometric variables are described in Table 1.

Table 1- *Cephalometric Variables*

Maxillary and mandibular skeletal	
SNA (°)	**Angle formed by SN and NA planes**
Co-A (mm)	**Linear distance from Condylion to point A**
A-NPerp (mm)	**Linear distance from A-point to perpendicular to Frankfort plane through N**
SNB (°)	**Angle formed by SN and NB planes.**
Co-Gn (mm)	**Linear distance from Condylion to gnathion**
Pog-NPerp (mm)	**Linear distance from Pogonion to perpendicular to Frankfort plane through N;**
ANB (°)	**Angle formed by NA and NB planes.**
Wits (mm)	**Linear distance between the perpendiculars of points A and B in the occlusal plane**
Vertical Skeletal	
FMA (°)	**Angle formed by the intersection of Frankfurt plane and Go-Me**
SN .GoGn (°)	**Angle formed by SN and GoGn planes.**
SN.Occlusal Plane (°)	**Angle formed by SN and Occlusal plane**
Lower Face Height (ANS-Me) (mm)	**Linear measurement from anterior nasal spine to menton**
Maxillary dentoalveolar	
Mx1.NA (°)	**Angle between maxillary incisor and NA line**
Mx1.PP (°)	**Angle between maxillary incisor and Palatal plane**
Mx1-NA (mm)	**Linear distance from maxillary incisor to NA line**
Mx1-PP (mm)	**Linear distance from maxillary incisor to Palatal plane**

Mx6-PTV (mm)	**Linear distance from the centroid of the maxillary first molar perpendicular to the Pterygoid Vertical Plane (PTV)**
Mx6-PP (mm)	**Linear distance from the centroid of the maxillary first molar to Palatal plane**
Mx6.SN (°)	**Angle formed by the intersection of the long axis of the maxillary first molar and the SN line. The first molar long axis was determined by a line passing through the central point between the two root apices and the centroid point**
Mandibular Dentoalveolar	
Md1.NB (°)	**Angle between mandibular incisor and NB line**
IMPA	**Angle formed by the intersection of the long axis of the mandibular incisor and mandibular plane**
Md1- NB (mm)	**Linear distance from mandibular incisor to NB line**
Md1-GoMe (mm)	**Perpendicular distance between incisal edge of mandibular incisor and mandibular plane**
Md6- Crown to Symphysis (mm)	**Distance between the mandibular first molar mesial point and the pogonion-perpendicular line (PogPerp)**
Md6.GoMe (°)	**Angle formed between the line that passes through the occlusal contact point of the first molars and the apex of the mesial root of the first mandibular molar and mandibular plane**
Interdental	
Overjet (mm)	**Linear horizontal distance from incisal of maxillary incisor to incisal of mandibular incisor**
Overbite (mm)	**Linear vertical distance from incisal of maxillary incisor to incisal of mandibular incisor**
Molar relationship (mm)	**Linear distance from MI to MS. The more negative values mean more severe Class III**
Soft tissue	
Lower Lip – S Line (mm)	**Linear distance from the most anterior point on the lower lip to a plane from the center of the S-shaped curve between the tip of the nose and the skin subnasale to the soft-tissue pogonion**
Upper Lip – S Line (mm)	**Linear distance From the most anterior point on the upper lip to a plane from the center of the S-shaped curve between the tip of the nose and the skin subnasale to the soft-tissue pogonion**
Facial convexity: G'-Sn-Po' (°)	**Angle formed between glabella, skin subnasale and soft tissue pogonion**
Nasolabial Angle (Col-Sn-UL) (°)	**Angle formed by the most anterior point on the upper lip to a line from subnasale to columella**

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The magnification of each x-ray machine, ranging from 6% to 10.2%, was corrected with Dolphin Imaging Premium software (Dolphin Imaging and Management Solutions, Chatsworth, Calif. USA.

Comprehensive orthodontic treatment was carried out with preadjusted 0.022x0.028-inch Roth and Bio-functional prescriptions (Morelli® Ortodontia, Sorocaba, Brazil). The following archwire sequence was used for both groups: 0.014 and 0.016-inch NiTi round archwires, 0.017x0.025 and 0.019x0.025-inch NiTi and 0.019x0.025-inch stainless steel archwires. Class III mechanics with 3/16-inch (4.58oz) elastics were initiated only when 0.019x0.025-inch stainless steel archwires were placed. All Class III elastics were worn from the hooks of the maxillary first molar to the mandibular canine. The archwires were tied with elastic ligatures, and the mandibular canines were tied with stainless-steel ligatures to prevent canine rotation.

Error study

One month after the first measurement, 51 lateral cephalograms were randomly selected, retraced and remeasured by the same examiner. The random errors were calculated according to Dahlberg's formula[23], and the systematic errors were evaluated with dependent t-tests[24].

Statistical analyses

The normal distribution of the variables was evaluated with Kolmogorov-Smirnov tests. All variables showed normal distribution.

Intergroup comparability regarding sex distribution and Class III malocclusion severity were evaluated with chi-square tests.

Intergroup comparability regarding pre and post-treatment age, treatment time, time of use of elastics and rectangular archwires, initial Little Irregularity index and cephalometric statuses were evaluated with t-tests.

Intergroup comparisons regarding the final cephalometric statuses and treatment changes (T2-T1) were evaluated with t-tests.

All statistical analyses were performed with Statistica software (Statistica for Windows 7.0; Statsoft, Tulsa, Okla). Results were considered statistically significant at P<0.05.

RESULTS

The random errors varied from 0.18 (Mx6-PP and Upper Lip-S Line) to 0.47mm (Co-Gn and Mx6-PTV) for linear measurements and from 0.16º (MI.GoMe) to 0.95º (ANB) for angular measurements, which were within acceptable ranges[25,26]. Only two variables demonstrated significant systematic errors.

The groups were comparable regarding sex distribu-

tion, Class III malocclusion severity, pre and post-treatment ages, treatment time, time of use of Class III elastics and rectangular archwires and Little irregularity index (Table 2). At the pretreatment stage (T1), the Biofunctional group had a significantly greater Class III molar relationship than the Roth group (Table 3).

€Chi-Square test; ¥t tests.

Table 2- *Comparison of sex and Class III malocclusion severity distribution, initial and final age, treatment times, time of use of elastics and Little irregularity index*

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Variables	1-Biofunctional n=36		2-Roth n=48		P
Sex Male Female	13 23		20 28		0.605€
Occlusal malocclusion severity ¼ cusp Class III ½ cusp Class III ¾ cusp Class III Full cusp Class III	10 15 8 3		34 9 4 1		0.658€
	Mean	SD	Mean	SD	P
Initial age	20.04	8.04	19.45	8.46	0.748¥
Final age	22.58	8.13	22.10	8.57	0.796¥
Treatment time	2.53	0.84	2.64	0.99	0.600¥
Time of use of elastics	0.70	0.23	0.74	0.32	0.533¥
Time of use of rectangular archwires	0.61	0.26	0.63	0.26	0.704¥
Little	4.72	3.63	3.77	3.33	0.220¥

At the posttreatment stage (T2), the Roth group maxillary incisors were significantly more labially tipped than the Biofunctional group, and the Biofunctional group mandibular molars presented greater distal angulation than the Roth group (Table 4).

During treatment, the Roth group presented significantly greater counterclockwise rotation of the occlusal plane, labial tipping and protrusion of the maxillary incisors, and smaller extrusion of the maxillary incisors than the Biofunctional group (Table 5). The Roth group also presented significantly greater mandibular incisor lingual tipping and smaller mandibular molar distal angulation than the Biofunctional group.

Table 3 – *Pretreatment Intergroup Cephalometric Comparison (t-tests)*

VARIABLES	BIOFUNCTIONAL (T 1)		ROTH (T 1)		P
	Mean	s.d.	Mean	s.d.	
Maxillary and mandibular skeletal					
SNA (°)	**82.78**	**4.07**	**82.14**	**4.17**	**0.480**
Co-A (mm)	**78.97**	**4.77**	**79.64**	**5.02**	**0.538**
A-NPerp (mm)	**1.23**	**2.98**	**1.33**	**3.92**	**0.893**
SNB (°)	**83.24**	**3.61**	**82.07**	**3.24**	**0.123**
Co-Gn (mm)	**113.27**	**7.19**	**111.65**	**7.83**	**0.335**
Pog-NPerp (mm)	**4.42**	**4.72**	**2.32**	**5.30**	**0.064**
ANB (°)	**-0.21**	**2.83**	**0.69**	**2.28**	**0.110**
Wits (mm)	**-4.81**	**2.93**	**-3.60**	**2.94**	**0.064**
Vertical Skeletal					
FMA (°)	**26.02**	**4.54**	**25.78**	**4.74**	**0.813**
SN .GoGn (°)	**31.77**	**6.45**	**32.23**	**4.98**	**0.711**
SN.Occlusal Plane (°)	**13.39**	**5.10**	**14.83**	**3.65**	**0.135**
Lower Face Height (ANS-Me) (mm)	**64.87**	**7.18**	**65.05**	**5.73**	**0.899**

Maxillary dentoalveolar					
Mx1.NA (°)	**29.58**	**6.06**	**27.33**	**6.49**	**0.109**
Mx1.PP (°)	**120.33**	**4.71**	**118.38**	**5.72**	**0.100**
Mx1-NA (mm)	**5.92**	**2.94**	**5.14**	**2.60**	**0.202**
Mx1-PP (mm)	**26.11**	**2.97**	**27.07**	**3.16**	**0.158**
Mx6-PTV (mm)	**20.32**	**3.50**	**18.84**	**4.02**	**0.081**
Mx6-PP (mm)	**19.78**	**2.49**	**19.16**	**3.18**	**0.338**
Mx6.SN (°)	**79.70**	**5.44**	**77.88**	**6.28**	**0.167**
Mandibular Dentoalveolar					
Md1.NB (°)	**21.51**	**5.37**	**24.13**	**5.20**	**0.026**
IMPA	**85.13**	**5.95**	**87.45**	**5.92**	**0.080**
Md1- NB (mm)	**4.72**	**2.45**	**5.43**	**2.11**	**0.158**
Md1-GoMe (mm)	**38.35**	**4.07**	**37.71**	**3.39**	**0.430**
Md6- Crown to Symphysis (mm)	**18.09**	**2.51**	**17.31**	**3.01**	**0.211**
Md6.GoMe (°)	**58.96**	**12.53**	**59.85**	**11.86**	**0.739**
Interdental					
Overjet (mm)	**0.56**	**1.84**	**1.03**	**1.77**	**0.242**
overbite (mm)	**0.01**	**2.16**	**0.66**	**1.59**	**0.115**
Molar relationship (mm)	**-5.09**	**1.46**	**-4.47**	**1.02**	**0.023***
Soft tissue					
Lower Lip – S Line (mm)	**0.30**	**2.67**	**0.90**	**2.27**	**0.2690**
Upper Lip – S Line (mm)	**-1.97**	**1.98**	**-1.41**	**1.79**	**0.1754**
Facial convexity: G'-Sn-Po' (°)	**7.85**	**5.66**	**9.32**	**3.79**	**0.1574**
Nasolabial Angle (Col-Sn-UL) (°)	**106.63**	**8.99**	**107.05**	**11.78**	**0.8597**

*Statistically significant at $P<0.05$.

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Table 4- *Posttreatment Intergroup Cephalometric Comparison (t-tests)*

VARIABLES	BIOFUNCTIONAL (T 2)		ROTH (T 2)		P
	Mean	s.d.	Mean	s.d.	
Maxillary and mandibular skeletal					
SNA (°)	**82.91**	**3.93**	**82.60**	**4.31**	**0.740**
Co-A (mm)	**79.08**	**4.69**	**80.05**	**5.04**	**0.373**
A-NPerp (mm)	**1.10**	**3.52**	**1.34**	**3.56**	**0.753**
SNB (°)	**104.01**	**3.27**	**82.09**	**3.09**	**0.227**
Co-Gn (mm)	**114.11**	**7.07**	**112.60**	**7.64**	**0.337**
Pog-NPerp (mm)	**3.92**	**5.32**	**2.44**	**4.94**	**0.191**
ANB (°)	**0.12**	**2.75**	**0.94**	**2.02**	**0.118**
Wits (mm)	**-3.17**	**2.51**	**-2.52**	**2.76**	**0.273**
Vertical Skeletal					
FMA (°)	**26.90**	**4.91**	**26.29**	**4.69**	**0.559**
SN .GoGn (°)	**32.02**	**6.76**	**32.08**	**5.34**	**0.963**
SN.Occlusal Plane (°)	**12.85**	**5.09**	**11.49**	**2.55**	**0.111**
Lower Face Height (ANS-Me) (mm)	**66.49**	**7.08**	**66.40**	**5.77**	**0.945**
Maxillary Dentoalveolar					
Mx1.NA (°)	**30.36**	**6.84**	**32.47**	**5.33**	**0.115**
Mx1.PP (°)	**121.33**	**5.69**	**124.08**	**5.39**	**0.025***
Mx1-NA (mm)	**7.08**	**3.10**	**6.16**	**2.21**	**0.114**
Mx1-PP (mm)	**27.15**	**2.92**	**27.06**	**3.18**	**0.889**
Mx6-PTV (mm)	**21.80**	**3.62**	**20.93**	**3.69**	**0.285**
Mx6-PP (mm)	**20.92**	**2.41**	**20.42**	**2.89**	**0.404**
Mx6.SN (°)	**83.91**	**4.38**	**83.49**	**5.01**	**0.689**
Mandibular Dentoalveolar					
Md1.NB (°)	**20.14**	**3.55**	**19.10**	**4.08**	**0.224**
IMPA	**83.74**	**6.21**	**82.62**	**5.54**	**0.385**
Md1- NB (mm)	**4.69**	**2.03**	**4.95**	**2.24**	**0.581**
Md1-GoMe (mm)	**40.69**	**4.61**	**40.45**	**3.24**	**0.779**

Md6- Crown to Symphysis (mm)	**19.23**	**2.28**	**18.26**	**3.07**	**0.117**
Md6.GoMe (°)	**47.91**	**11.36**	**54.01**	**9.59**	**0.009***
Interdental					
Overjet (mm)	**2.77**	**0.64**	**2.92**	**0.80**	**0.353**
Overbite (mm)	**1.54**	**0.79**	**1.38**	**0.82**	**0.371**
Molar relationship (mm)	**-2.31**	**0.80**	**-2.06**	**0.85**	**0.682**
Soft tissue					
Lower Lip – S Line (mm)	**-0.11**	**2.53**	**0.57**	**2.21**	**0.191**
Upper Lip – S Line (mm)	**-1.30**	**1.96**	**-0.83**	**2.26**	**0.321**
Facial convexity: G'-Sn-Po' (°)	**8.51**	**5.20**	**10.07**	**4.64**	**0.149**
Nasolabial Angle (Col-Sn-UL) (°)	**105.77**	**9.29**	**107.33**	**11.87**	**0.514**

**Statistically significant at P<0.05.*
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Table 5- *Intergroup treatment changes comparison (t-tests)*

VARIABLES	BIOFUNCTIONAL (T 2 – T 1)		ROTH (T 2 – T 1)		P
	Mean	s.d.	Mean	s.d.	
Maxillary and mandibular skeletal					
SNA (°)	**0.12**	**1.10**	**0.46**	**2.12**	**0.379**
Co-A (mm)	**0.11**	**1.05**	**0.40**	**1.07**	**0.209**
A-NPerp (mm)	**-0.13**	**1.50**	**0.01**	**2.15**	**0.737**
SNB (°)	**20.77**	**125.05**	**0.02**	**1.19**	**0.252**
Co-Gn (mm)	**0.85**	**1.51**	**0.95**	**2.07**	**0.797**
Pog-NPerp (mm)	**-0.49**	**2.44**	**0.12**	**3.66**	**0.388**
ANB (°)	**0.33**	**0.86**	**0.25**	**1.09**	**0.716**
Wits (mm)	**1.64**	**1.85**	**1.08**	**1.97**	**0.186**
Vertical Skeletal					
FMA (°)	**0.88**	**1.56**	**0.51**	**1.97**	**0.350**
SN .GoGn (°)	**0.25**	**1.41**	**-0.15**	**1.71**	**0.254**
SN.Occlusal Plane (°)	**-0.54**	**1.79**	**-3.34**	**2.73**	**0.000***
Lower Face Height (ANS-Me) (mm)	**1.62**	**2.24**	**1.35**	**1.83**	**0.537**
Maxillary Dentoalveolar					
Mx1.NA (°)	**0.78**	**2.81**	**5.14**	**4.42**	**0.000***
Mx1.PP (°)	**0.98**	**3.89**	**5.70**	**4.36**	**0.000***
Mx1-NA (mm)	**1.16**	**1.46**	**1.02**	**1.71**	**0.684**
Mx1-PP (mm)	**1.05**	**1.32**	**-0.01**	**1.61**	**0.001***
Mx6-PTV (mm)	**1.48**	**2.15**	**2.09**	**1.59**	**0.136**
Mx6-PP (mm)	**1.14**	**1.42**	**1.26**	**1.60**	**0.723**
Mx6.SN (°)	**4.20**	**4.63**	**5.60**	**4.16**	**0.149**
Mandibular Dentoalveolar					
Md1.NB (°)	**-1.37**	**4.15**	**-5.03**	**4.85**	**0.000***
IMPA	**-1.38**	**5.12**	**-4.82**	**5.25**	**0.003***
Md1- NB (mm)	**-0.03**	**1.54**	**-0.48**	**1.46**	**0.179**
Md1-GoMe (mm)	**2.34**	**2.23**	**2.75**	**2.02**	**0.385**
Md6- Crown to Symphysis (mm)	**1.14**	**1.66**	**0.95**	**1.52**	**0.598**
Md6.GoMe (°)	**-11.04**	**9.85**	**-5.84**	**6.60**	**0.004***
Interdental					
Overjet (mm)	**2.21**	**1.73**	**1.89**	**1.60**	**0.3889**
Overbite (mm)	**1.53**	**2.29**	**0.72**	**1.52**	**0.0546**
Molar relationship (mm)	**2.96**	**1.56**	**2.41**	**1.16**	**0.0664**
Soft tissue					
Lower Lip - S Line (mm)	**-0.41**	**1.64**	**-0.33**	**1.74**	**0.8273**
Upper Lip - S Line (mm)	**0.67**	**1.17**	**0.57**	**1.74**	**0.7750**
Facial convexity: G'-Sn-Po' (°)	**0.66**	**2.65**	**0.75**	**3.60**	**0.8933**
Nasolabial Angle (Col-Sn-UL) (°)	**-0.86**	**6.95**	**0.29**	**8.15**	**0.4982**

**Statistically significant at P<0.05.*
Research date source

DISCUSSION

Although the groups were comparable in most cephalometric variables, the Biofunctional group presented a significantly greater Class III molar relationship than the Roth group (Table 3). However, since this was the only significantly different variable, it can be assumed that the groups were very similar.

At the posttreatment stage, the Roth group maxillary incisors were significantly more labially tipped than the Biofunctional group (Table 4). This was expected as an unfavourable result from using Class III elastics. The Roth group has labial torque on the maxillary incisors, and the Biofunctional group has zero torque. Therefore, consequent to the mesial force applied on the maxillary teeth, the incisors will be labially flared in the Roth group. On the other hand, the zero torque of the incisors in the Biofunctional group counteracts the mesial force applied by the Class III elastics, and the maxillary incisors tend to move bodily with minimum labial tipping. This has been previously demonstrated[11,13,18].

The mandibular first molars finished more distally angulated in the Biofunctional than in the Roth group at the posttreatment stage (Table 4). The intermaxillary Class III elastics produce distal angulation of the mandibular molars[27]. As the Biofunctional group presented a significantly greater Class III molar relationship at the pretreatment stage and, therefore, a greater need for Class III elastics use, this could have produced considerably greater distal angulation of the mandibular first molars.

During treatment, the Roth group showed a significantly greater counterclockwise occlusal plane rotation than the Biofunctional group (Table 5). This counterclockwise rotation of the occlusal plane occurs due to the known effects of intermaxillary Class III elastics[18,28,29]. It is speculated that this greater counterclockwise rotation of the occlusal plane inclination in the Roth group is due to the significantly greater retroclination of the mandibular incisors during treatment. This retroclination results from the zero torque of the incisor brackets, which do not provide enough labial resistant torque to these teeth when Class III elastics are used.

The maxillary incisors had greater labial tipping in the Roth group than in the Biofunctional group. The greater palatal resistant torque in the Biofunctional group prevented the maxillary incisors from excessively tipping labially, and the teeth tended to have greater bodily movement. Consequently, the maxillary incisors also had greater vertical development in the Biofunctional group. The excessive labial tipping of the incisors in the Roth group maintained the dentoalveolar height of these teeth. This is in agreement with previous studies[11,13].

The Roth group also had greater lingual tipping of the mandibular incisors than the Biofunctional group. The explanation is similar to the maxillary incisors. The greater labial resistant torque of the Biofunctional groups prevented excessive lingual tipping of the mandibular incisors during the use of Class III elastics[11,13]. Possibly, the controlled movement of these teeth may induce a greater alveolar bone remodelling response[11,29,30].

As previously discussed, there was greater distal angulation of the mandibular molars in the Biofunctional group, probably because it had a greater initial Class III anteroposterior discrepancy.

Clinical implications

The Biofunctional seems to be an excellent alternative to minimize the Class III elastics side effects on the maxillary and mandibular incisors.

CONCLUSION

- *There were greater maxillary and mandibular incisors, labial and lingual tipping, and greater occlusal plane counterclockwise rotation in the Roth than in the Biofunctional prescription;*
- *Therefore, compensatory Class III malocclusion treatment performed with the Biofunctional prescription minimizes the side effects of Class III elastics.*

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