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Dentoskeletal and aesthetic effects of mandibular protraction appliance (MPA) using Ricketts analysis

Efeitos dentoesqueléticos e tegumentares do aparelho de protração mandibular (APM) usando a análise cefalométrica de Ricketts

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Resumo

Objetivo: Este estudo analisou as alterações dentárias, esqueléticas e tegumentares promovidas pelo Aparelho de Protração Mandibular (APM) por meio da análise de Ricketts. **Material e método:** A amostra contou com 27 pacientes (14 meninas e 13 meninos) com má oclusão de Classe II, perfil facial convexo, trespasse horizontal aumentado e deficiência mandibular, com idade média inicial de 12,27 e final de 15,18 anos, tratados com aparelho fixo combinado com o APM. A comparação das telerradiografias iniciais (T1) e finais (T2) foi realizada pelo teste t dependente, com nível de significância de 5%. **Resultado:** Observou-se diferença estatisticamente significante para a retrusão (p=0.000) e lingualização dos incisivos superiores (p=0.000), protrusão (p=0.000) e vestibularização dos incisivos inferiores (p=0.000), aumento do ângulo interincisivos (p=0.002), melhora da relação molar (p=0.003), restrição do deslocamento anterior da maxila (p=0.000), diminuição do ângulo do plano mandibular (p=0.024) e melhora do perfil facial (p=0.000). **Conclusão:** O APM promoveu alterações dentoalveolares, observadas principalmente pela diminuição do ângulo do plano mandibular e restrição do deslocamento para anterior da maxila que contribuíram para a melhora do perfil do paciente.

Descritores: Má oclusão de Classe II de Angle; aparelho ortodôntico funcional; avanço mandibular.

Abstract

Objective: This study was designed to evaluate the skeletal, dental and soft tissue effects of mandibular deficiency treatment with the mandibular protraction appliance (MPA) using 12 factors of the Ricketts analysis. **Material and method:** This cross-sectional retrospective study sample consisted of a group (n = 27), with Class II malocclusion, convex facial profile, increased horizontal trespass and mandibular deficiency, with initial mean age of 12.27 and final of 15.18 years, treated with fixed appliance combined with the MPA, in an average time of 2.9 years. Initial and final radiographs were investigated using Ricketts analysis. The dependent t-test was used to compare the initial and final phases of the MPA group, with a significance level of 5%. **Result:** Statistically significant differences were observed for dental changes such as retrusion (p=0.000) and palatal inclination of the maxillary incisors (p=0.000); protrusion (p=0.000) and buccal inclination of the mandibular incisors (p=0.000); increased interincisal angle (p=0.002) and improved molar ratio (p=0.003). There was also a restriction of the anterior displacement of the maxilla (p=0.000) and a decrease in the mandibular plane angle (p=0.024). The variable inferior labial protrusion with significance (p=0.000), reiterated the improvement in the profile. **Conclusion**: The effects of MPA on correction of malocclusion Class II, verified by Ricketts analysis occurred predominantly by dentoalveolar changes, decrease in the Mandibular Plane Angle, and restriction of anterior displacement of the maxilla, which contributed to the improvement in the patient's profile.

Descriptors: Angle class II malocclusion; functional orthopedic appliance; mandibular advancement.

INTRODUCTION

In general, malocclusions are related to dental and skeletal alterations[1]. Several studies have shown a number of skeletal and dental combinations involved in Class II[2,3], such as protruding jaw, retruded mandible, or both. However, mandibular retrognathism is the most prevalent feature[2-4].

Mandibular deficiency may be treated by means of orthopedic mandibular advancement, and the device used depends on acquired knowledge and preference of the orthodontist and the patient's cooperation[2]. To eliminate the cooperation factor, fixed mandibular advancement devices have been introduced[5]. At present, due to

the development of orthodontics, several mandibular appliances have been reported in literature for the treatment of Class II malocclusion, such as Herbst, Jasper Jumper, Twin Force, Mara, Forsus, among others[6-9].

However, some disadvantages such as rigidity, the need for laboratory work such as crowns or special bands of the Herbst apparatus and their high cost led to Coelho[10] developing the Mandibular Protraction Appliance (MPA). This MPA appliance, now available in its fourth version, offers advantages such as the possibility of being manufactured by the professionals themselves, in addition to being easily inserted and used in combination with the fixed appliance[10-12].

Several authors have studied the effects of Class II treatment by means of cephalometric evaluation[13,14], including cephalometric changes in MPA treatment[3,13,15] but there is a scarcity of studies in the literature assessing the effects of mandibular protraction by the Ricketts Analysis. Those that used Ricketts, only evaluated alterations in the profile, mesialization of the first molars, and verified the upper airway space[16-18]. Because there is no more comprehensive study on the effects of MPA, using Ricketts, the purpose of this study was to investigate which changes would be promoted by the mandibular protraction from the perspective of this analysis.

MATERIAL AND METHOD

This study was approved by the Research Ethics Committee of the Institution at which it was conducted (43712215.2.0000.5385). The sample size was calculated considering α = 0.05, power of the study (β) = 80% and by using the findings of a study conducted by Henriques et al.[19]. Power analysis showed a minimum sample of 23 subjects. After analysis of the MPA sample, 27 patients were included.

The retrospective study sample consisted of 27 patients (14 girls and 13 boys) who were treated with fixed appliances combined with the mandibular protraction appliance (MPA)[17]. The initial mean age of the patients was 12.27 years; final age, 15.18 years, and the mean treatment time were 2.9 years. All patients had Angle Class II Division 1 malocclusions bilaterally, no agenesis or loss of permanent teeth, no supernumerary or impacted teeth, no tooth size or shape anomalies, no inferior or minimal crowding, a convex facial profile, increased overjet, mandibular skeletal retrusion (SNB=76.50º), and maxillomandibular relationship with standard horizontal growth (FMA=23º), and a 3/4 Class II molar ratio on an average, since the mean molar ratio was 1.29.

The MPA appliances were fabricated according to Coelho[10-12]. The device was inserted and maintained in use for an average period of 7 months. After the active period of MPA use, the molars presented a Class I relationship, with a significant reduction in overjet.

Lateral cephalograms were obtained at two observation time intervals: T1, at the onset of treatment and T2, at the end of MPA therapy. The magnification factor was 9%. The Ricketts analysis[20] was the instrument used to evaluate the lateral cephalograms of the treated group according to the following criteria: dental relation, dentoskeletal relationship, maxillomandibular relationship, craniofacial relationship and aesthetic relations, selecting 12 variables for this study (Figure 1). The maxillary convexity, facial depth, mandibular plane angle and position of the lower lip showed increments of -0.2mm / year; 0.33º / year; -0.33º / year, and -0.2mm / year in their final values, respectively, for these measures to become scientifically validated, thus allowing us to gauge the changes that occurred as a result of growth[21]. The measures were scientifically validated by means of these increments, and allowed us to evaluate whether these changes would, or would not occur with the individual's normal growth and development, thus eliminating the need for a control group. In order to verify the intra-examiner error, 30 teleradiographs were randomly selected within one month, and showed the reliability of the results. According to the formula proposed by Dahlberg[22], no significant random and systematic errors were found, with the exception of the interincisive angle (p= 0.006). This error was understandable since the greatest degree of variation in both the vertical and horizontal directions occurred in determining the apex of the mandibular incisor[23].

Statistical Analysis

Since all variables showed a normal distribution (Kolmogorov-Smirnov test), parametric tests was used. The dependent t-test was used for interphase comparison in the MPA group (Table 1). The tests were performed using the software Statistica for Windows, version 7.0 (Statsoft, Tulsa, Okla, USA), with a significance level set at 5% (p <0.05).

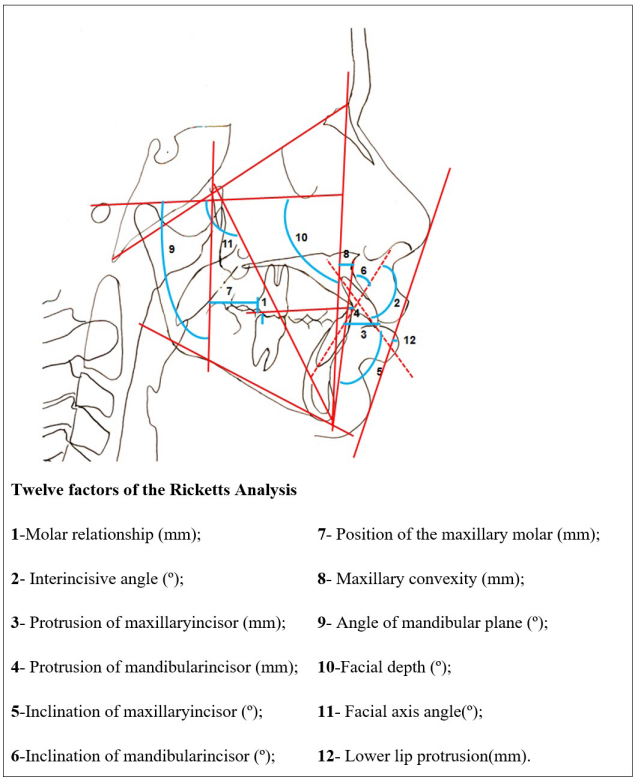

Figure 1. Lines and plans used to obtain the 12 cephalometric variables of the Ricketts analysis.

Table 1. Comparison between the initial and final phases of the APM group (t-dependent test) (N = 27)

Variables	Initial phase T1		Final phase T2		P
	Average	s.d.	Average	s.s.	
Dental relationships					
MR (mm)	1.29	2.82	-1.00	1.62	**0.003***
IA (°)	116.62	8.89	123.24	7.92	**0.002***
Dentoskeletal relationships					
PUI (mm)	9.53	2.07	5.24	2.37	**0.000***
PLI (mm)	-0.03	2.64	2.38	2.41	**0.000***
IUI (°)	41.35	6.47	26.44	5.62	**0.000***
ILI (°)	22.24	6.95	29.70	5.28	**0.000***
PMM (mm)	17.33	3.90	18.14	3.48	0.134
Maxillomandibular relationship					
MC (mm)	4.74	3.07	2.60	3.06	**0.000***
Craniofacial relationship					
MPA (°)	23.18	5.77	22.05	6.35	**0.024***
FD (°)	88.27	2.28	90.49	2.42	**0.000***
FAA (°)	90.22	4.45	90.14	4.52	0.874
Aesthetic relationship					
Li-E (mm)	-0.96	2.63	-2.48	2.17	**0.000***

*Statistically significant for P < 0.05.

RESULT

The dependent t-test was used to compare the initial and final phases T1 and T2 (Table 1), emphasizing significant difference (p <0.05) in dental and dentoskeletal relationships, with improvement in the molar ratio (p=0.003) and increase in interincisive angle (p=0.002); in addition to retraction (p=0.000) and palatal inclination of the maxillary incisors (p=0.000), and protrusion (p=0.000) and buccal inclination of the mandibular incisors (p=0.000).Restriction of maxillary anterior displacement (p=0.000) was also observed when the bone bases were evaluated. For the craniofacial relations, MPA showed a significant decrease (p <0.05) in the mandibular plane angle (p=0.024) and increase in facial depth (p=0.000), suggesting an anti-clockwise rotation of the mandible during orthodontic mechanics and MPA in the treatment of Class II malocclusion. In relation to the maxillary molar, there was no significant difference in the restriction of its mesialization (p=0134), during the action of MPA. Finally, the significant difference in the E line (p=0.000) showed improvement in the profile in patients who underwent orthodontic/orthopedic intervention.

DISCUSSION

In this study, the Ricketts analysis was used to evaluate the dental, skeletal and profile alterations in a group of patients submitted to treatment with MPA. The results will be discussed considering the effects of MPA on the correction of Class II malocclusion, reiterating that the cephalometric variables had increased, which allowed us to contemplate the changes that would occur as a result of growth[21]. To evaluate the results, we did not consider a control group because the increments were substantiated by the author of the analysis[20], and these (values) showed that the variables of this study incorporated the changes that would occur with the normal growth of the individual; that is, the results of this study did not occur without the action of the MPA in correction of the sagittal discrepancy. Moreover, it is possible to observe other studies that have evaluated the effects of mandibular protraction in the treatment of Class II, without including a control group in the study[4,13,16,24].

The MPA improved the molar ratio and increased the interincisive angle, which could be explained by lingualization of the maxillary incisors[10,25] and vestibularization of the mandibular incisors[13,24]. According to the original proposal of the MPA, the main concern related to mandibular advancement was to maintain the inclination of the mandibular incisors [11,12]. As regards the molar relationship, this was in agreement with previous studies that indicated mesialization of the mandibular molar[17] as a result of mandibular advancement[13,24].

Relative to dentoskeletal changes, there was palatine retraction, inclination of the maxillary incisors and protrusion and vestibularization of the mandibular incisors, changes that have also been shown in other studies[9,10,24]. The literature, however, shows the risk of gingival recession in excessive vestibularization of the mandibular incisors[15]. Indeed, the greatest concern with the use of MPA was to preserve

the axial inclination of the mandibular incisors, because their excessive vestibular inclination should not be allowed[11].

Within the field of dentoskeletal relationships, it was important to note that there was no significant restriction of maxillary molar mesialization. This was also be observed in other studies that showed the improvement in Class II would occur to a larger extent by mesialization of the mandibular molar[9,13] and mild limitation of anterior displacement of the maxillary first molars[9,13].

According to the methodology used, there was significant restriction of maxillary anterior displacement, a restriction that was also highlighted in another study[25]. However, in a comparative study between MPA, Jasper Jumper and a Class II control group, there was no significant restriction of anterior maxillary growth in comparison with the control group[19], and the same result was found in another study[24]. However, according to the methodology used and the results of the Ricketts analysis, there was significant anterior displacement of the maxilla.

A decrease in the mandibular plane angle and increase in facial depth were verified, which corroborated the findings of another study[9] that also verified anti-clockwise rotation of the occlusal plane. This significant difference in the mandibular plane angle was, however, not found in other studies[3,13,15,19]. According to the methodology used in the present study, this variable presented statistically significant values for anti-clockwise rotation of the mandible. With regard to increase in the facial depth value, which showed the occurrences in the mandible, this could be explained by its anti-clockwise rotation of the mandible, since the MPA results suggested that an action of Extrabuccal Anchorage (AEB)[24] had occurred. This increase may, therefore, be related to a new postural position of the mandible and not indicate that there had been real growth. In the literature, we also observed other findings related to mandibular changes when using mandibular protraction[9,10,12,24,25].

The significant difference in Line E was also verified, showing that on conclusion of the treatment there was an improvement in the profile provided by the treatment with MPA. This fact justified the changes that occurred in relation to the distance of Line E from the lower part of the lower lip. This was in agreement with other studies that evaluated the tegumentary effects of mandibular protraction - similar to the MPA, which had significant effect on improvement of the profile[13-15].

The authors reiterate that since the Ricketts variables presented the compensations that would occur with growth[21], their significance allowed us to affirm that the results of the treatment of Class II, Division 1 by means of MPA and fixed appliances would not have occurred simply by the normal growth and development of the individual.

In general, from a clinical point of view, the correction of Class II, Division 1 malocclusion predominantly occurred due to dentoalveolar changes, in agreement with Coelho[10], who stated that the main alterations resulting from MPA were of a dentoalveolar order, especially with the lingual inclination of the maxillary incisors, and the labial inclination of the mandibular incisors. Moreover, according to the methodology used, the improvement of Class II occurred by restricting the anterior displacement of the maxilla and by the anti-clockwise rotation of the mandible. Furthermore, because the correction occurred in major dentoalveolar components, according to the Ricketts analysis, MPA can also be used in both growing and adult patients[13]. As there were few studies that have evaluated the changes promoted by the mandibular protraction appliance, by means of using the Ricketts Analysis, the authors suggest that further studies must be conducted to enable comparison with the results of this research.

CONCLUSION

The effects of MPA in the correction of Class II malocclusion, verified by the Ricketts Analysis, predominantly occurred due to dentoalveolar changes; the decrease in the mandibular plane angle, and restriction of anterior displacement of the maxilla, variables that were not significant in the majority of other studies, and that contributed to the improvement in the patients' profile.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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