Original Article

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Mandibular behavior in the treatment of skeletal Class II malocclusion: a 5-year post-retention analysis

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Abstract

Aim: This study aimed to assess mandibular behavior in Class II subjects subjected to full orthodontic treatment with standard edgewise appliance and cervical headgear (Kloehn appliance) during the pubertal growth spurt period. **Methods:** Lateral cephalometric radiographs of 40 patients (21 females and 19 males) were performed at the beginning of the treatment (T_0), at its end (T_1) and at 5-year post-retention phase (T_2) in order to quantify the cephalometric measurements (8 angular and 3 linear), representing the mandibular behavior in the anteroposterior and vertical senses. The mean age of female patients at T_0, T_1 and T_2 was 11.4, 15 and 26 years, respectively, and for male patients it was 12.2, 16.7 and 28 years, respectively. All patients were treated in just one phase without extractions and not associating Class II intermaxillary elastics. **Results:** The effective treatment of skeletal Class II malocclusion with conventional Edgewise fixed appliance and Kloehn cervical headgear did not interfere in the direction and amount of mandibular growth as well as remodeling at it is inferior border, with no influence in anti-clockwise rotation of the mandible. The mandibular growth was also observed after the orthodontic treatment, suggesting that it is influenced by genetic factors. **Conclusion:** These observations may lead to the speculation that growing patients with skeletal Class II malocclusion and low mandibular plane are conducive to a good treatment and long-term stability.

Keywords: skeletal Class II malocclusion, mandibular behavior, Kloehn cervical headgear, post-retention

Introduction

Class II malocclusion is an abnormal anteroposterior relationship between the dental arches in which mandible and mandibular arch are distally positioned in relation to maxilla and maxillary dentition[1]. The resulting convex profile involves maxillary protrusion, mandibular retrusion or combination of both[2].

Magnitude and direction of craniofacial growth, particularly the mandibular growth, are factors influencing the treatment of Class II malocclusion. The capacity of foreseeing the mandibular displacement might help both planning and orthodontic treatment mechanics[3]. The child's facial growth from year to year is not regular in terms of amount and direction, and the vertical growth components are crucial in the anteroposterior displacement of the mandible[1]. A successful treatment of Class II malocclusion in young people depends on the proper orthodontic mechanics, patient cooperation and how satisfactorily growth spurt occurs at the age ranges of 10-13 in girls and 11-14 years in boys[4].

During the normal craniofacial growth, the mandible suffers a translational movement when the condylar growth is the same like to the maxillary sutures and alveolar processes. On the other hand, a greater condylar growth will result in anterior displacement of the mandible[2].

Ricketts[5] reported that condylar growth towards antero-superior direction will increase the facial depth and the brachiocephalic pattern. However, a condylar growth towards a posterior-superior direction will result in an increase in the facial height with dolichocephalic trends.

Kloehn[6] has suggested that Class II malocclusions should be treated with cervical traction

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during mixed dentition followed by fixed orthodontic appliance without tooth extractions because of mandibular alveolar processes and tooth shift forward during normal growth. If the mandible grows normally and the maxillary growth is restrained, it will be achieved a good relationship between the anatomical structures[6]. There are several negative effects of orthodontic treatment, as follow: decrease in anticlockwise rotation of the mandible and pogonion, increase in Y-axis angle and mandibular plane, as well as increase in anterior facial height, probably due to excessive extrusion of upper molars[7-8].

However, these data are not corroborated by Hubbard et al.[9], who reported that one cannot presume that the negative effects of cervical traction will occur in whole Class II patients treated, because there are several variables involved in it, such as angulation of mandibular plane, techniques for using and adjusting the Kloehn appliance, besides the patient age.

Bjork[10] has shown that the increase in Y-axis angle and mandibular plane is related to the fact that the lower border of the mandible is frequently remodeled, thus camouflaging its anti-clockwise rotation, which is directly associated to amount and direction of condylar growth[5].

Patients with normal vertical facial proportion, with undergo orthodontic treatment during the growth spurt phase, have tendency to present more favorable results and long-term stability. The clockwise rotation of the mandible resulting from cervical traction therapy is transient in most growing individuals, returning to anti-clockwise rotation after treatment because of the residual growth[11-13].

The objective of the present study was to assess the changes in mandibular behavior on patients subjected to full orthodontic treatment with standard Edgewise appliance and cervical traction headgear during the pubertal growth spurt period by analyzing the data obtained in the active phase of the orthodontic treatment and after at least 5 years of retention.

Material and methods

The UFRJ's Ethics Committee approved the development of this study under the protocol number (CAAE 54/2009 – 0050.0.339.000/09).

This clinical research was based on 40 Brazilian Caucasian individuals, 21 girls and 19 boys, who underwent full Edgewise appliance and cervical-pull headgear treatment during 48 months in the Postgraduate Orthodontic Program of the Federal University of Rio de Janeiro. All patients were treated in just one phase without extractions and not associating Class II intermaxillary elastics. The cervical headgear was applied during 12 hours/day with an average force of 400 g, being used in a mean of 24 months during the pubertal growth spurt period. Each patient was evaluated three times by lateral cephalometric radiographs: at the beginning of the treatment (T0), at the end of the active orthodontic treatment (T1), and after at least 5 years of retention (T2).

All the subjects were in the pubertal growth spurt period at the beginning of the orthodontic treatment, with skeletal pattern of Class II evidenced by ANB angle > 5º and Wits >0 mm. The skeletal maturity stage of all individuals was analyzed in hand and wrist radiographs. The dental relationship was of Class II, according to Angle's classification. The individuals also exhibited SNGoGn angle $\leq$ 35º. The age interval for female patients at T_0 was 10-13 years (mean = 11.4 years; SD = $\pm$ 0.64); at T_1 was 12.9-17.6 years (mean = 15 years; SD = $\pm$ 1.42), and at T_2 was 20.5-29.6 years (mean = 26 years; SD = $\pm$ 3.91). The range interval for male patients at T_0 was 11.2-14 years (mean = 12.2 years; SD = $\pm$ 0.9); at T_1 was 14.5-19.9 years (mean = 16.7 years; SD = $\pm$ 2.12), and at T_2 was 20.5-29.6 years (mean = 28 years; SD = $\pm$ 5.23).

The cephalograms were obtained by delimitating skeletal, dental and tegumentary structures. The measurements from cephalometric tracings regarding T_0, T_1 and T_2 were tabulated for statistical analysis, with angular measurements being rounded up whenever decimal fraction existed. Changes in mandibular displacement were measured in relation to skull base by the following angles: SNB, SND, SNGoGn, SNGoMe, CdGoGn, Y-axis, Facial angle, and FMA (Figure 1). The linear measurements were used to describe, separately, the mandibular components: CdGo (height of mandibular ramus); CdPog (total mandibular length) and GoPog (mandibular body length) (Figure 2).

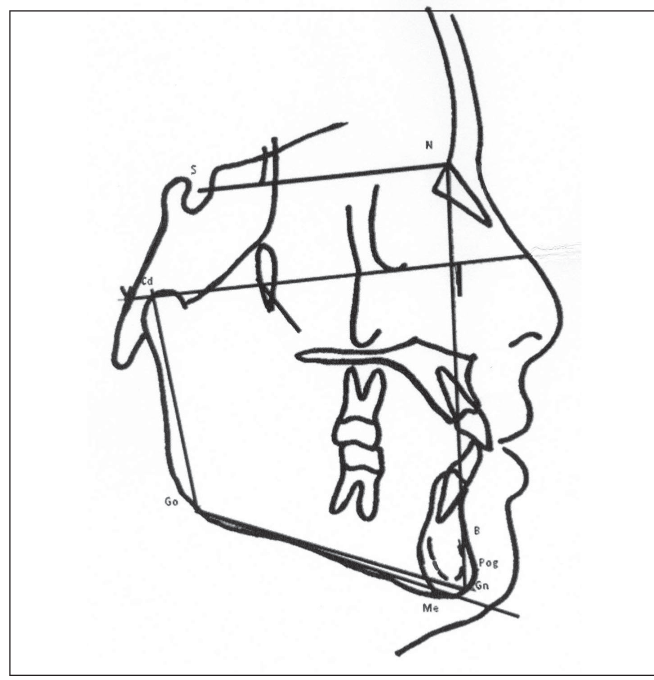

Fig. 1. Cephalogram illustrating angular measurements used in the study: SNB, SND, SNGoGn, SNGoMe, CdGoGn, Y-axis, Facial angle and FMA.

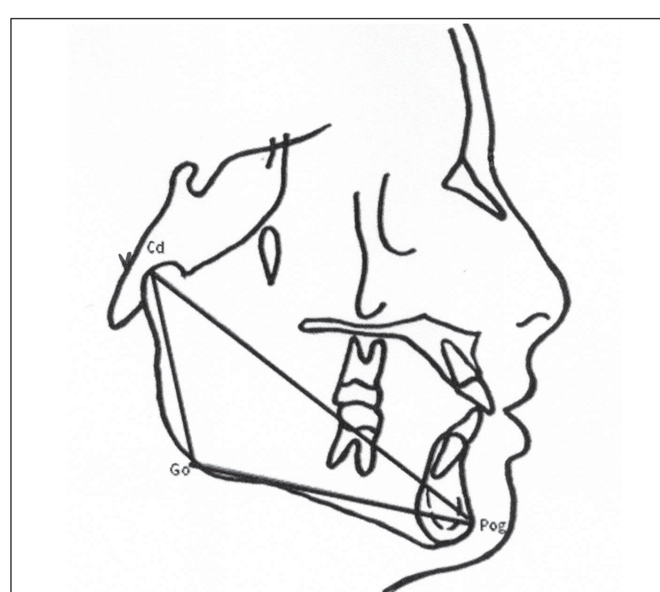

Fig. 2. Cephalogram showing linear measurements (mm) used in the study: CdGo, CdPog, and GoPog.

Table 1. Means and standard deviations for angular and linear measurements regarding the study group at the beginning of treatment (T_0), at the end of treatment (T_1), and at the 5-year post-retention period (T_2).

	T_0Mean SD	T_1Mean SD	T_2Mean SD	*p* between T_0 x T_1	*p* between T_1 x T_2
SNB (°)	76.25 ± 2.67	77.95±2.76	79.00 ± 2.84	< .001**	< .001**
SND (°)	73.25 ±2.67	74.90 ± 2.82	76.00 ± 2.86	< .001**	< .001**
SNGoGn (°)	31.85± 2.08	30.65 ± 2.00	29.60 ± 1.98	< .001**	< .001**
SNGoMe (°)	32.90± 2.10	31.35 ± 2.32	30.30 ± 2.36	<.001**	< .001**
CdGoGn (°)	124.25±5.48	121.45± 4.65	119.35 ± 4.71	< .001**	< .001**
Eixo Y (°)	58.25± 4.94	57.80 ± 4.28	57.95 ± 4.26	.20 n.s	.18 n.s
Facial (°)	83.75± 3.91	85.50 ± 3.39	86.60 ± 3.39	< .001**	< .001**
FMA (°)	26.05± 5.36	24.20 ± 4.42	23.20 ± 4.12	.001**	< .001**
CdGo (mm)	5.0 ± 0.41	5.67 ± 0.40	6.01 ± 0.49	< .001**	< .001**
CdPog(mm)	10.68± 0.56	11.66 ± 0.41	12.34 ± 0.36	< .001**	< .001**
GoPog mm)	7.23 ± 0.47	7.89 ± 0.41	8.41 ± 0.39	< .001**	< .001**

SD = standard deviation **= 1% significant level n.s= no significant

The error of the method was evaluated by 30 radiographs chosen at random, traced and digitized by the same investigator on 2 separate occasions at least 2 months apart. The Dahlberg formula was used: ME $=\sqrt{\Sigma d^2/2n}$, where n is the number of duplicate measurements. Random errors varied between 0.26 and 0.92mm for linear measurements and between 0.28° and 1.1° for angular measurements.

Means and standard deviations were calculated for each cephalometric measurement at T_0, T_1, and T_2. The statistical treatment of the data between T_0 x T_1 as well as between T_1 x T_2 was analyzed using the paired Student's t-test with 5% significance level.

Results

Table 1 showed means and standard deviations for angular and linear measurements at T_0, T_1, and T_2 as well as the *P* values between T_0 x T_1 and T_1 x T_2. Tables 2 and 3 present data on female and male patients, respectively. Figure 3 illustrates total superimposition at T_0, T_1, and T_2 for SN, while Figure 4 represents the partial superimposition at T_0, T_1, and T_2 for Ar.

Discussion

The skeletal changes resulting from facial growth, which occurs during the transition from deciduous to permanent dentition, do not correct the Class II malocclusion established at an earlier age. It probably happens due to the morphological characteristics of the Class II malocclusion, justifying a therapeutic intervention during growth spurt[14-15].

By assessing the mandibular behavior of the study group, it was observed that conventional Edgewise fixed appliance and Kloehn cervical headgear mechanics used for orthodontic treatment did not interfere with mandibular growth and displacement, since the mean values for SNB angle had a statistically significant increase in the T_0 x T_1 interval. This demonstrated a favorable mandibular growth in relation to the skull base during the phase of active orthodontic treatment, which was confirmed by the expressive increase in SND angle. Similar conditions were observed in the T_1 x T_2 interval regarding the mean SNB and SND angles, which might be the result of residual mandibular growth after the active orthodontic treatment period (Table 1)[14].

Table 2. Means and standard deviations for angular and linear measurements regarding female patients at the beginning of treatment (T_0), at the end of treatment (T_1), and at 5-year the post-retention period (T_2).

	T_0Mean SD	T_1Mean SD	T_2Mean SD	*p* between T_0 x T_1	*p* between T_1 x T_2
SNB (°)	76.82± 2.99	78.36 ± 3.13	79.55± 3.17	< .001**	< .001**
SND (°)	73.82± 2.85	75.18 ± 3.02	76.36± 3.07	< .001**	<.001**
SNGoGn (°)	31.45± 2.38	30.36 ± 2.37	29.35 ± 2.36	< .001**	< .001**
SNGoMe (°)	32.82± 2.63	31.55± 2.62	30.82 ± 2.56	<.001**	<.001**
CdGoGn (°)	123.18± 3.92	120.55 ±4.08	118.36±4.38	.004**	.001**
Eixo Y (°)	58.73± 3.60	58.18± 1.99	58.36± 2.11	.40 n.s	.34 n.s
Facial (°)	83.27± 3.31	85.55± 2.33	86.73± 2.19	.004**	.001**
FMA (°)	26.91± 4.01	24.36 ± 2.06	23.45 ± 2.20	.007**	.005**
CdGo (mm)	4.92± 0.42	5.53 ± 0.39	5.79 ± 0.38	<.001**	.018**
CdPog(mm)	10.6 ± 0.65	11.50± 0.43	12.10± 0.41	<.001**	<.001**
GoPog(mm)	7.24 ± 0.48	7.83 ± 0.40	8.40 ± 0.37	< .001**	<.001**

SD = standard deviation **= 1% significant level n.s= no significant

Table 3. Means and standard deviations for angular and linear measurements regarding male patients at the beginning of treatment (T_0), at the end of treatment (T_1), and at the 5-year post-retention period (T_2).

	T_0Mean SD	T_1Mean SD	T_2Mean SD	*p* between T_0 x T_1	*p* between T_1 x T_2
SNB (°)	75.56± 2.18	77.44 ± 2.29	78.45± 2.27	<.001**	<.001**
SND (°)	72.56± 2.40	74.56 ± 2.69	75.57 ± 2.65	<.001**	< .001**
SNGoGn (°)	32.33± 1.65	31.00 ± 1.50	29.89± 1.45	<.001**	.001**
SNGoMe (°)	33.0 ± 1.32	31.11 ± 2.02	29.67± 2.06	.020*	.001**
CdGoGn (°)	125.56±6.98	122.56± 5.29	120.56 ±5.07	.012**	.002**
Eixo Y (°)	57.67± 6.40	57.33 ± 6.18	57.44± 6.08	.081 n.s	.347 n.s
Facial (°)	84.33± 4.69	85.44 ± 4.50	86.44± 4.61	< .001**	< .001**
FMA (°)	25.0 ± 6.78	24.0 ± 6.40	22.89± 5.84	< .001**	<.001**
CdGo(mm)	5.1 ± 0.41	5.84 ± 0.37	6.28 ± 0.46	<.001**	.002**
CdPog mm)	10.78± 0.44	11.85 ± 0.32	12.50± 0.20	<.001**	<.001**
GoPog(mm)	7.21± 0.48	7.95 ± 0.44	8.41 ± 0.45	.001**	< .001**

SD = standard deviation *= 5% significant level **= 1% significant level n.s= no significant

With regard to the profile, it was found a mean reduction of the facial convexity in the time intervals, which was confirmed by a significant increase in the facial angle. This fact can be supported by the anterior positioning of the mandible during facial growth (Tables 1-3; Figures 3 and 4) as well as bone apposition in the region of pogonion[5,16].

The cephalometric evaluation showed a trend to the decrease of the angles related to the mandibular plane during growth due to the intrinsic morphogenetic characteristic of the studied cases[17-18]. All

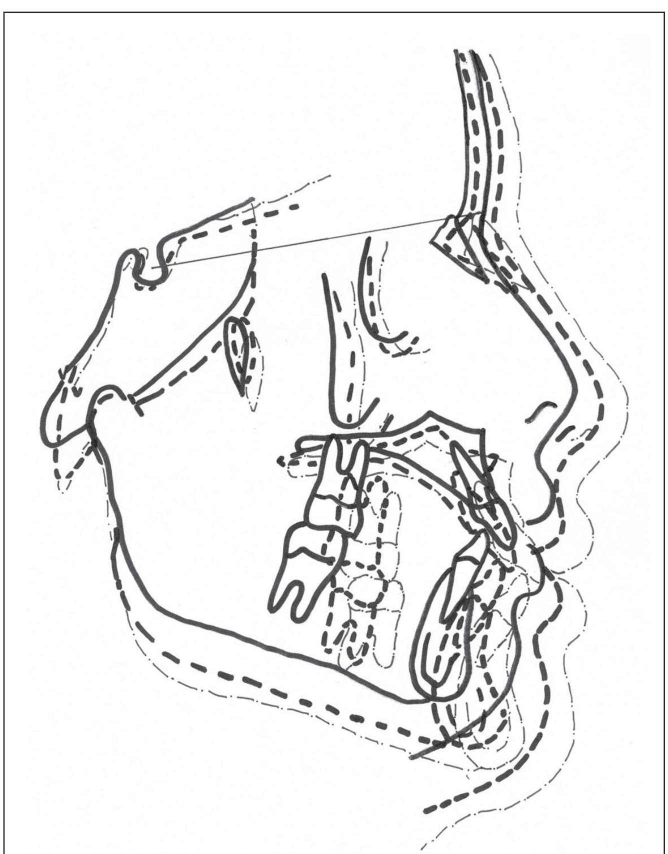

Fig. 3. Total superimposition of tracings for SN at T_0 (____), T_1 (_ _ _), and T_2 (_ . _ .).

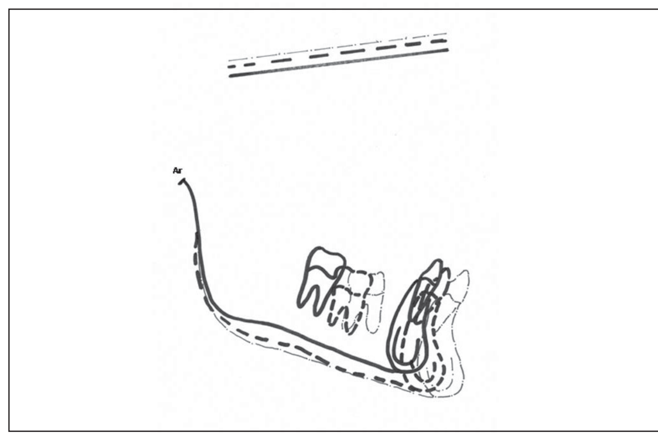

Fig. 4. Partial superimposition of tracings for Ar at T_0 (____), T_1 (_ _ _), and T_2 (_ . _ .).

patients subjected to orthodontic treatment presented low mandibular plane, which is crucial factor for using cervical traction as cited elsewhere[2,5,16]. The mean values for SNGoGn, SNGoMe, CdGoGn and FMA angles showed a significant reduction in the time interval, suggesting that rotation of the mandible is governed by the direction and amount of condylar growth and remodeling at the inferior border of the mandible (Table 1, Figures 3 and 4)[14,18-19].

According to the structural analysis established by Björk[3] the mandibular rotation depends on the morphogenetic pattern, that is determined by mandible's morphology. The vertical growth of mandibular condyles should be greater than that of posterior alveolar processes, being an important factor in the anticlockwise rotation of the mandible[20]. Nevertheless, the changes observed in the Y-axis angle revealed the harmonic pattern of facial growth in male and female patients during orthodontic treatment and post-retention phases (Tables 2 and 3)[11,21-22].

Analysis of the linear measurements CdGo, CdPog, and GoPog (Table 1) showed a significant increase in T_0 x T_1 and T_1 x T_2 intervals. These data also suggest that mandibular growth occurs during the active orthodontic treatment as well as post-retention period, including an increase in both mandibular ramus and body. According to the literature, the mandibular growth is more prominent than maxilla growth, continuing for an additional period of time[11,21,23].

When the mandibular displacement was evaluated separately for males and females, it was observed that the mean values for SNB, SND and Facial angles were significantly increased in both genders between T_0 x T_1 and between T_1 x T_2, thus supporting the genetic influence on mandibular growth and displacement (Tables 2 and 3)[5,16-18].

Amount and direction of mandibular growth are genetically determined. The lower border of the mandible influences the mandibular plane angle because of its bone remodeling (Tables 2 and 3)[10]. The mean values for SNGoGn, SNGoMe, CdGoGn, and FMA angles were reduced in both genders patients between T_0 x T_1, thus demonstrating favorable anticlockwise rotation. It was confirmed by the significant reduction in CdGoGn and FMA angles[2,4]. Between T_1 x T_2, all the angular measurements cited above were found to be significantly decreased for all patients, thus suggesting that both growth and displacement of the mandible are determined by genetic factors (Tables 2 and 3)[3,10].

By analyzing the mean values regarding linear measurements CdGo, CdPog, and GoPog (Tables 2 and 3), it was found a significant increase in both time intervals for both genders. This emphasized the mandibular growth observed during and after the active orthodontic treatment phase. Similar results were also found by other authors, who reported a residual mandibular growth[11,21,23]. Bone apposition in the region of pogonion occurs continuously even after active treatment has finished[16-18].

Full corrective orthodontic treatment, using standard Edgewise technique and cervical headgear (Kloehn appliance), was considered effective in patients with skeletal Class II malocclusions and low mandibular plane. The treatment did not interfere on mandibular growth, which happened during the active treatment as well as it had finished. These observations are in agreement to the tendency that growing patients with skeletal Class II malocclusion and low mandibular plane are conducive to better results of orthodontic treatment and long-term stability.

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