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Long-term Anteroposterior and Vertical Maxillary Changes in Skeletal Class II Patients Treated with Slow and Rapid Maxillary Expansion

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ABSTRACT

Objective: To evaluate a 10-year follow-up of anteroposterior and vertical maxillary changes in skeletal Class II patients treated with slow and rapid maxillary expansion methods.

Materials and Methods: The sample consisted of 70 patients divided into two groups: (1) treated with a cervical headgear with expansion of the inner bow (CHG) and (2) using a Haas-type rapid maxillary expansion appliance in conjunction with cervical headgear (RME-CHG). The CHG group consisted of 40 patients (18 males and 22 females; average age 10.6 years at pretreatment [T_1], 13.6 years at posttreatment [T_2], and 23.6 years at postretention [T_3]). The RME-CHG group consisted of 30 patients (14 males and 16 females; average age 10.4 years at T_1, 14.0 years at T_2, and 24.6 years at T_3). The profiles of SNA and SN-PP angles showed no significant differences in either group at T_1, T_2, and T_3 phases.

Results: For the entire sample, the profile analysis between the phases showed reduction in the SNA angle from T_1–T_2 and an increase from T_2–T_3. The SN-PP angle showed an increase from T_1–T_2 and a decrease from T_2–T_3. Treatment of skeletal Class II patients with slow and rapid maxillary expansions was efficient and stable over the long-term.

Conclusions: The profiles of SNA and SN-PP at T_1, T_2, and T_3 achieved with slow and rapid maxillary expansions were clinically equivalent.

KEY WORDS: Skeletal Class II, Maxillary changes, Maxillary expansion, Long-term.

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INTRODUCTION Return to TOC

The maxilla differs from the mandible in that the former is composed of two distinct bones joined at the midpalatal and intermaxillary sutures. This anatomical characteristic allows greater orthopedic effects. Class II malocclusion is related to a narrow maxilla. Therefore, a transverse expansion of the maxillary arch is necessary to correct this anomaly.[1]

The transverse maxillary expansion can be obtained through slow or rapid maxillary expansion. Rapid maxillary expansion (RME) is a mechanical procedure that utilizes great forces and is designed to produce maximum skeletal response with minimum tooth movements.[2] After RME, as the two halves of the maxilla rotate anteriorly and laterally away from their posterior articulations, point A is displaced anteriorly.[3] The initial downward and forward movement of the maxilla, together with a downward and backward rotation of the mandible,[4] produce a negative effect on the Class II correction. This has been demonstrated to be temporary because the maxilla and the mandible tend to return to their original positions during the stabilization period.[5]

The cervical headgear has been used for correction of skeletal Class II malocclusion mainly in the mixed dentition when the skeletal system is more dynamic and easily remodeled. If treatment of a Class II malocclusion is started during the transitional dentition, after the eruption of first premolars, 90% of the cases are successfully corrected.[6] Although the Kloehn cervical headgear is the most frequently used appliance, there are still controversies regarding its influence in relation to the SNA angle,[7] first molar extrusion,[8,9] and palatal plane.[10,11] When the inner bow of the appliance is expanded laterally, there is slow apical base expansion that promotes a significant widening of the maxillary dental arch and an increase in intranasal capacity.[12]

The long-term effects of slow and rapid maxillary expansions in the skeletal Class II treatment are not found in the literature. Thus, studies are necessary to verify the clinical benefits of these therapies in this type of malocclusion. The objective of this study is to evaluate the long-term (10-year follow-up) behavior of anteroposterior and vertical maxillary changes in skeletal Class II patients treated with slow and rapid maxillary expansions.

MATERIALS AND METHODS Return to TOC

The sample consisted of 70 patients selected consecutively from the file records of the Lima Ortodontia Clinic in São José do Rio Preto, State of São Paulo, Brazil, by one practitioner. The inclusion criteria were: (1) skeletal Class II with ANB ≥ 5°; (2) treatment by nonextraction; (3) same fixed appliance therapy after obtaining Class I molar relationship;

(4) absence of intermaxillary Class II elastics, and (5) same retention protocol at the end of treatment. The option for rapid maxillary expansion was based on the severity of the transverse discrepancy. The 70 patients were divided into 2 groups: (1) slow maxillary expansion employing cervical headgear with expanded inner bow (CHG) and (2) rapid maxillary expansion using a tissue-borne Haas-type RME appliance followed by cervical headgear (RME-CHG) (Figure 1).

The CHG group consisted of 40 patients, 18 males and 22 females. The RME-CHG group consisted of 30 patients, 14 male and 16 female. The sample age characteristics are shown in Table 1.

The extraoral appliance used in this study was a Kloehn cervical headgear recommended to be worn for 12 to 14 hours per day. The force applied for the 70 patients averaged 450 g. The patients were seen monthly when attention was given to three areas of adjustment: (1) the inner bow was maintained at a 4 to 8 mm expansion; (2) the outer bow was maintained at a 10° to 20° elevation to prevent distal tipping of the molars, and (3) the ends of the inner bow were adjusted to rotate the molars.

All palatal expanders were manufactured at the same clinic. The expansion rate was two quarter turns (0.5 mm) per day until adequate overexpansion was achieved when the lingual cusps of the upper posterior teeth approximated the buccal cusps of the lower posterior teeth as determined by clinical observation. The RME appliance was left cemented in place for 3–9 months while extraoral traction was applied against the maxilla. A loose removable acrylic plate was placed within 48 hours of removing the expander. Each patient wore the acrylic plate for a variable amount of time, usually one year.

In the lateral cephalometric radiographs, the degree of image distortion was determined using a 100 mm correction ruler adapted to the patient, on the midsagittal plane. Kodak T-Mat™ film (20.3 × 25.4 cm) was used and placed on the left side of the cephalostat, to avoid image enlargement beyond 8% in relation to the structures.[13]

Cephalometric points were digitized (Numonics Corp, model AccuGrid XNT A30BL, Montgomeryville, Pa), according to Ortho lateral regimen and processed with Dentofacial Planner Plus software, version 2.5b (DentoFacial Software Inc, Toronto, Ontario, Canada). The angular measurements included SNA (maxillary protrusion) and SN-PP (maxillary inclination).

To evaluate the reproducibility of the present research in determining the cephalometric points, preliminary tests were performed to determine the errors in the method employed. Eleven randomly chosen lateral cephalograms were digitized at predetermined intervals (minimum two weeks) between the first and the second. The largest error was 0.8° and the smallest was 0.1°.

The hypotheses consisted of verifying through profile analysis the differences in the measurements taken at pretreatment (T_1), posttreatment (T_2), and postretention (T_3). Analysis included:

H_{01}: Are the profiles parallel?

H_{02}: Assuming the profiles are parallel, are the profiles coincident?

H_{03}: Assuming the profiles are coincident, are the profiles level?

The data were statistically analyzed by using exploratory analyses for the variables studied in the T_1, T_2, and T_3 phases. In hypotheses H_{01} and H_{02}, Hotelling´s T^2 test was used to test the profile of each group. In H_{03}, the F-Snedecor test was applied to the entire sample when H_{01} and H_{02} results were nonsignificant. When these results were significant, the F-Snedecor test was applied separately to each group. The multiple comparisons between phases were tested by the Bonferroni method,[14] considering the differences of phases for paired data.

RESULTS Return to TOC

The results of the descriptive statistics for all measurements at T_1, T_2, and T_3 in CHG and RME-CHG groups are shown in Table 2.

According to Hotelling's T^2 test (H_{01}, H_{02}, and H_{03}), the profiles of SNA and SN-PP angles showed no significant differences in both groups throughout the T_1, T_2, and T_3 phases (Table 3). For this reason, the F-Snedecor test was applied to the entire sample. For the entire sample (CHG + RME-CHG) the profile analysis between the phases showed a mean reduction of 2.9° in the SNA angle from T_1–T_2 and a mean increase of 0.9° from T_2–T_3 (Figure 2). The SN-PP angle showed a mean increase of 1.6° from T_1–T_2 and a mean decrease of 0.7° from T_2–T_3 (Figure 3). These mean differences of SNA and SN-PP angles between the treatment phases were statistically significant.

DISCUSSION Return to TOC

The profile of the SNA and SN-PP angles in the CHG and RME-CHG groups showed no significant differences at the T_1, T_2, and T_3 phases, thus demonstrating that both slow and rapid maxillary expansion produced similar short- and long-term anteroposterior and vertical changes in skeletal Class II correction. Although all patients presented with skeletal Class II, the option for rapid maxillary expansion was based on the severity of the transverse discrepancy.[5] A comparison with the literature is troublesome because long-term follow-up studies on skeletal Class II patients treated with cervical headgear are scarce. Moreover, no study was found on skeletal Class II patients treated with cervical headgear in conjunction with a rapid maxillary expansion appliance.

Among the benefits of RME is the loosening of the circumaxillary sutures as part of the Class III correction with facemask therapy.[15] In the RME-CHG group, a Kloehn cervical headgear was placed at the time of stabilization of the palatal appliance. Theoretically, due to the disruption of the hafting sutures, the entire maxilla would be displaced downward and backward more easily with a greater decrease in the SNA angle in the RME-CHG group. However, in the present investigation, both groups showed similar reductions in maxillary protrusion.

In the profile analysis between treatment phases of the entire sample, the SNA angle decreased from T_1– T_2 (2.9°) which is in agreement with previous studies.[16] The SNA angle is expected to remain unchanged or even increase without treatment.[17] Chung and Wong[18] found that the SNA angle increased from ages 9 to 18 years in untreated skeletal Class II subjects. Although in support of the efficacy of Class II treatment with cervical headgear, some investigators found small differences in SNA reduction.[19,20] Differences in results can be attributed to the types of appliances, treatment duration, daily hours of headgear wear, and amount of force applied. According to Riolo et al[21] during normal growth, the SNA angle increases 0.4° in male patients and 0.3° in female patients from 10 to 13 years of age. Over the long-term, in the present investigation, the SNA angle increased 0.9°.

The effects of skeletal Class II correction in the SN-PP angle with slow and rapid maxillary expansions for the entire sample were statistically significant for T_1– T_2 with an increase of 1.7° and for T_2–T_3 with a decrease of 0.7°. Several studies observed similar changes in the SN-PP angle in patients treated with cervical headgear.[22,23] During normal growth the palatal plane descends in a parallel manner to the cranial base.[24,25] Other studies on untreated Class I patients showed small increases in the SN-PP angle, but these changes were not clinically relevant.[21,26]

The anterior descent of the PP probably occurred due to the posterior and inferior repositioning of maxillary growth by the action of cervical traction. Although the forces produced distally on the upper molars cause molars to erupt downward and backward, they inhibit the lowering of the posterior region of the maxilla, while the anterior region continues to move downward during growth (Figure 4).[27] Aspects such as the age of the patient at the beginning of treatment and the patient's compliance may have contributed to the SN-PP angle increase.

CONCLUSIONS Return to TOC

- Skeletal Class II treatment with slow and rapid maxillary expansions associated with cervical headgear was efficient and stable over the long-term.
- The profiles of the SNA and SN-PP angles throughout the pretreatment, posttreatment, and postretention phases were clinically equivalent with both slow and rapid maxillary expansion.

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TABLES Return to TOC

Table 1. Mean Age and Range (Years) of Skeletal Class II Patients at Pretreatment (T1), Postreatment (T2), and Postretention (T3)[a]

Phase	CHG n	CHG Mean	CHG Range	RME-CHG n	RME-CHG Mean	RME-CHG Range
T_1	40	10.6	8.10–13.2	30	10.4	7.1–15.0
T_2	40	13.6	11.7–16.4	30	14.0	11.0–17.7
T_3	40	23.6	17.6–33.5	30	24.6	17.1–36.3

[a] CHG indicates cervical headgear with expansion of the inner bow; RME-CHG, rapid maxillary expansion appliance in conjunction with cervical headgear; n, number of subjects.

Table 2. Descriptive Statistics of Measurements Obtained From 40 CHG and 30 RME-CHG Patients at Pretreatment (T1), Posttreatment (T2), and Postretention (T3)[a]

Measures	Phase	CHG Mean	CHG SD	CHG Min	CHG Max	RME-CHG Mean	RME-CHG SD	RME-CHG Min	RME-CHG Max
SNA[b]	T_1	83.4	3.05	76.1	88.6	81.6	4.22	71.6	88.0
	T_2	80.2	3.94	70.9	86.1	79.1	3.56	70.0	85.0
	T_3	81.0	3.29	75.0	87.0	80.1	3.85	68.6	87.1
SN-PP[b]	T_1	6.1	3.10	−0.4	11.5	6.0	3.18	0.1	13.2
	T_2	7.8	3.39	1.5	15.0	7.6	3.50	1.4	16.6
	T_3	7.3	3.15	1.0	13.6	6.6	3.74	−0.6	15.7

[a] CHG indicates cervical headgear with expansion of the inner bow; RME-CHG, rapid maxillary expansion applicance in conjunction with cervical headgear. SD, standard deviation; Min, minimum; Max, maximum.

[b] Angular measurements (degrees).

Table 3. Results of Hotelling's T2, F Test, and P Values for the Hypotheses H01, H02, and H03; Mean of Difference (Dij), Standard Deviation of Difference Between Phases (SDij), and Confidence Interval for Multiple Comparisons Between Pretreatment (T1), Posttreatment (T2), and Postretention (T3)*

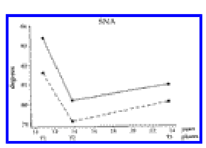
Measure (°)	H_{01} T^2	H_{01} P	H_{02} T^2	H_{02} P	H_{03} F	H_{03} P	Comparison	d_{ij}	SD_{ij}	CI
SNA	3.49	0.19	2.23	0.14	187.35	0.000+	T_1–T_2	2.9	1.8	[2.26; 3.54]
							T_1–T_3	2.0	2.1	[1.26; 2.78]
							T_2–T_3	−0.9	1.6	[−1.44; −0.31]
SN-PP	2.01	0.36	0.18	0.66	54.90	0.000+	T_1–T_2	−1.6	1.9	[−2.29; −0.96]
							T_1–T_3	−0.9	2.1	[−1.68; −0.19]
							T_2–T_3	0.7	1.6	[0.11; 1.25]

* $P < .05$; 0.000+, approximately zero; CI, 95% confidence interval of Bonferroni; a, CHG group; b, CHG-RME group.

FIGURES Return to TOC

Click on thumbnail for full-sized image.

Figure 1. Intraoral photographs of Haas-type rapid maxillary expansion appliance (A) and Kloehn cervical gear with expanded inner bow (B)



Click on thumbnail for full-sized image.

Figure 2. Mean profiles of SNA angle in pretreatment (T_1), posttreatment (T_2), and postretention (T_3) phases. —■— RME-Chg: rapid and slow maxillary expansions; —●— CHG: slow maxillary expansion

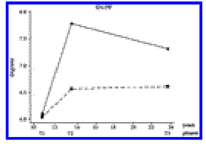


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Figure 3. Mean profiles of SN-PP angle in pretreatment (T_1), posttreatment (T_2), and postretention (T_3) phases. —■— RME-Chg: rapid and slow maxillary expansion; —●— CHG: slow maxillary expansion

Click on thumbnail for full-sized image.

Figure 4. Superimposition of cephalometric tracings of a skeletal Class II patient treated with rapid followed by slow maxillary expansions showing the inclination of the palatal plane

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