Early cephalometric characteristics in Class III malocclusion

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Objective: Early identification of craniofacial morphological characteristics allows orthopedic segmented interventions to attenuate dentoskeletal discrepancies, which may be partially disguised by natural dental compensation. To investigate the morphological characteristics of Brazilian children with Class III malocclusion, in stages I and II of cervical vertebrae maturation and compare them with the characteristics of Class I control patients.

Methods: Pre-orthodontic treatment records of 20 patients with Class III malocclusion and 20 control Class I patients, matched by the same skeletal maturity index and sex, were selected. The craniofacial structures and their relationships were divided into different categories for analysis. Angular and linear measures were adopted from the analyses previously described by Downs, Jarabak, Jacobson and McNamara. The differences found between the groups of Class III patients and Class I control group, both subdivided according to the stage of cervical vertebrae maturation (I or II), were assessed by analysis of variance (ANOVA), complemented by Bonferroni's multiple mean comparisons test.

Results: The analysis of variance showed statistically significant differences in the different studied groups, between the mean values found for some angular (SNA, SNB, ANB) and linear variables (Co – Gn, N – Perp Pog, Go – Me, Wits, S – Go, Ar – Go).

Conclusion: Assessed children displaying Class III malocclusion show normal anterior base of skull and maxilla, and anterior positioning of the mandible partially related to increased posterior facial height with consequent mandibular counterclockwise rotation.

Keywords: Angle Class III malocclusion. Cervical maturity. Cephalometry.

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INTRODUCTION

The Class III malocclusion shows prevalence around 3%, according to studies carried out in different population groups, including Brazilians[19]. Perhaps because of this low prevalence, early diagnosis, prognosis and the definition of appropriate time and therapeutic modalities suitable for its treatment remains a challenge to the orthodontist.

According to the data gathered from the records available at the Burlington Growth Center, it is possible to observe that in the different age groups analyzed, starting from 3 years of age, the occurrence of patients with Class III malocclusion was around 2%, except in the age of 6, where this percentage increased to about 4%.[14] On the other hand, when the same patients were cephalometricaly analyzed by linear differences between the maxillary and mandibular length, it was observed that until the age of six the occurrence of patients with skeletal relationship Class III demonstrated similar variation. However, starting from this age, the increase in the number of patients with Class III was progressive, until it reached a rate of approximately 12% of the assessed sample.[14] These differences probably are due to so-called natural dental compensation of skeletal discrepancies, that would become more evident after the six years old, on the occasion of the eruption of permanent incisors.[14]

Between the ages of 5 and 15 years, in a sample of Class III patients selected based on molar relationship, 25% present pure maxillary retrusion while less than 20% is related exclusively to mandibular prognathism.[8] Thus, the early identification of craniofacial morphological characteristics, by means of cephalometric data, provides orthopedic segmented interventions to attenuate dentoskeletal discrepancies, which may happen to be partially disguised by natural dental compensation.

A systematic literature review regarding the effectiveness of maxillary orthopedic protrusion to determine the existence of consensus on controversial issues — such as adequate time to treatment — revealed that the most significant orthopedic changes were observed in the earliest ages,[13] being the best stage for skeletal maxillary changes between four and seven years of age.[12] Overcorrected patients to a positive overjet of 4 to 5 mm or more, during the phase of orthopedic treatment, can usually maintain favorable results in long term.[21]

However, the response to treatments performed taking into consideration only the dental and chronological age parameters, becomes poorly predictable, due to the great variability of these patients' skeletal maturity stages. Among the different skeletal maturity indexes, the method that evaluates cervical vertebrae maturation has gotten well-deserved attention. It is based on morphological characteristics of cervical vertebrae at different stages of development, which correlate with different growth rates of the facial structures. This evaluation method presents 5 subsequent stages of maturation, being the mandibular growth peak comprised between the stages II and III.[2] An advantage of using this method lies in the fact that the assessment may be extracted from the lateral teleradiography routinely used for orthodontic diagnosis. In addition, it presents high reproducibility, reaching indexes ranging from 91 to 99%.[2]

The clinical decision to treat a patient who presents early Class III facial characteristics, but that still does not fulfill the criteria for the dental morphological classification could, therefore, find support in the ability to detect, on an individual level, some skeletal predicting characteristics of a developing Class III malocclusion.

The goal of this study is to investigate the craniofacial cephalometric characteristics of Brazilian children with Class III malocclusion in stages I and II of cervical vertebrae maturation and compare them with the ones displayed by Class I controls.

MATERIAL AND METHODS

The present study followed an observational and cross-sectional protocol, performed in the Preventive Orthodontics Clinic at the Medicine School of Petrópolis, Rio de Janeiro. The records of 20 patients with Class III malocclusion (11 females and 9 males, aged between 5 years and 10 months and 11 years and 3 months, mean age of 8 years and 6 months) and 20 control Class I patients matched by the same skeletal maturity stage and sex (ages between 5 years and 8 months and 11 years and 2 months, with a mean age of 8 years and 5 months) were selected from the pre orthodontic treatment records usually requested.

The inclusion criteria were: (1) Good quality of pre treatment lateral cephalometric radiographs obtained with the same cephalostat, and a focus-object distance of 1.55 m; (2) Class III molar relationship between the second deciduous molars or first permanent molars, determined by the analysis of dental casts of each patient and confirmed clinically by patient manipulation to centric relation ruling out the possibility of functional Class III and edge-to-edge relation or crossbite of incisors; (3) dental development stage of complete deciduous dentition or early mixed dentition; (4) skeletal development stages I or II, according to the index of cervical vertebrae maturation, characterizing the period preceding the outbreak of mandibular growth.[2] Patients with cleft lip or palate or any other dentofacial deformity were excluded.

The inclusion criteria for the control group were the same adopted for the study group, with the exception of the molar relationship which, for this group, became Angle's Class I of the second deciduous molars or first permanent molars determined by the analysis of the dental casts of each patient and clinically confirmed by manipulation of the patients to centric relation.

The lateral cephalometric radiographs were traced by one observer only and the cephalometric points were determined with a mechanical pencil with graphite tip of 0.3 mm on a polyester paper with 0.20 mm thick. The reference points were digitized in a system of X Y coordinates by Radiocef software (Radio Memory, Belo Horizonte, Brazil). The craniofacial structures and their relationships were divided into the following categories for analysis: Skull base, maxilla, mandible, intermaxilary relations and vertical facial relations (Table 1).

Linear and angular measurements were adopted from analyses before described by Downs,[6] Jarabak,[11] Jacobson[10] and McNamara.[16]

The measures found were tabulated and both the mean and standard deviation for each sample variable of Class III patient and Class I controls were calculated using the SPSS statistical software (SPSS Inc., Chicago, USA). The normality of angular and linear variables was examined by the Kolmogorov-Smirnov test, which showed that variables of both groups had normal distribution.

The differences found between means, for each of the selected variables, comparing the Group of Class III patients and the Group of Class I controls subjects, both subdivided according to the stage of cervical vertebrae maturation (I or II), were evaluated by analysis of variance (ANOVA) (Table 2) and complemented by Bonferroni's multiple comparisons test.

Differences which presented a chance lower than 5% of having occurred at random ($p<0.05$) were considered statistically significant. To test the magnitude of the measurement error for the cephalometric variables in this study, the lateral teleradiographies of 15 patients, randomly selected, were measured again through the use of Dahlberg's formula. The error was between 0.29 and 0.81 mm for linear measures and 0.34 and 0.93 for angular measures.

RESULTS

The means for both angular and linear cephalometric variables from the studied groups of patients are arranged in Table 2. This table represents the distribution of mean values and dispersion values (mean ± standard deviation) for linear and angular cephalometric variables for Class I and Class III patients groups, subdivided according to the pre-peak stage of cervical vertebrae maturation that each patient was in. The analysis of variance showed statistically significant differences, between the different groups

Table 1 - Angular (degrees) and linear (mm) cephalometric measures.

Skull base	Maxilla	Mandible	Intermaxillary Relation	Facial Height
S-N (mm)	SNA (degrees)	SNB (degrees)	ANB (degrees)	Ena-Me (mm)
S-AR (mm)	Co-A (mm)	Co-Gn (mm)	Mand. – Max.(mm)	S-Go (mm)
SNAr (degrees)	NperpA (mm)	NperpPog (mm)	Wits (mm)	N-Me (mm)
		Go-Me (mm)		Ar-Go (degrees)

Table 2 - Distribution of mean and dispersion values (mean standard deviation) of angular and linear cephalometric variables for the studied groups.

Variables	Class I		Class III		p value
	Stage 1 (1) (n = 10)	Stage 2 (2) (n = 10)	Stage 1 (3) (n = 10)	Stage 2 (4) (n = 10)	
Skull base					
S-N (mm)	65.99 ± 2.95	67.70 ± 2.73	65.80 ± 2.34	67.56 ± 3.56	0.329
S-Ar (mm)	31.82 ± 2.69	30.08 ± 3.42	31.01 ± 2.85	32.36 ± 1.90	0.300
N.S.Ar (°)	121.37 ± 6.13	122.37 ± 6.58	123.20 ± 1.75	122.77 ± 4.83	0.876
Maxilla					
SNA (°)	82.79 ± 2.08	79.69 ± 4.71*a	81.87 ± 2.65	83.88 ± 3.14*a	**0.048**
Co.A (mm)	82.86 ± 5.87	82.14 ± 4.33*a	82.23 ± 2.64	86.84 ± 5.40*a	0.100
N - Perp A (mm)	0.80 ± 2.45	0.55 ± 3.12	0.26 ± 2.59	0.92 ± 2.61	0.950
Mandible					
SNB (°)	78.44 ± 2.06	75.58 ± 4.04*a	80.51 ± 2.39*a	82.22 ± 3.24*a	**0.001**
Co - Gn (mm)	104.44 ± 6.96*a	104.93 ± 4.67	105.65 ± 5.97	112.35 ± 7.41*a	**0.028**
N - Perp Pog (mm)	-5.70 ± 5.95	-6.73 ± 6.02*a	-2.17 ± 4.22	-6.21 ± 5.74*a	**0.034**
Go - Me (mm)	65.27 ± 5.24	66.45 ± 3.63	68.30 ± 5.55	72.02 ± 6.16	**0.036**
Intermaxillary relation					
ANB (°)	4.35 ± 1.26*a	4.10 ± 1.49*b	1.36 ± 2.45*a	1.65 ± 2.17*b	**0.001**
Mand - Max (mm)	21.58 ± 3.59	22.75 ± 3.40	23.37 ± 4.07	25.44 ± 4.15	0.166
Wits (mm)	-1.28 ± 2.51	-0.20 ± 3.34*a	-3.96 ± 2.59	-4.15 ± 3.19*a	**0.009**
Facial height					
Ena - Me (mm)	63.38 ± 5.59	65.71 ± 4.63	60.50 ± 4.93	63.41 ± 5.24	0.175
S - Go (mm)	66.88 ± 4.62	66.58 ± 3.98*a	67.02 ± 4.20	72.03 ± 2.62*a	**0.011**
Na - Me (mm)	106.96 ± 7.57	111.88 ± 5.86	104.04 ± 5.65	109.45 ± 8.11	0.860
Ar - Go (mm)	39.58 ± 3.06	39.66 ± 2.27*a	39.15 ± 3.01	43.15 ± 2.89*a	**0.011**

$p \leq 0.05$. The groups differing each other by the analysis with multiple comparison test with Bonferroni's means were identified by same letters, *a and *b.

studied, for the mean values found for some angular variables (SNA, SNB, ANB) and linear variables (Co-Gn, N-Perp-Pog, Go-Me, Wits, S-Go, Ar-Go).

The analysis with Bonferroni's multiple comparisons test demonstrated which groups differ from each other (identified by the same letters, a and b).

DISCUSSION

The differential diagnosis of skeletal pattern as well as the dental classification of malocclusion are important factors in planning the orthodontic treatment. In some cases that show natural dental compensation the dental relation does not reflect exactly the actual skeletal pattern. A study evaluating the correlation between facial pattern and sagittal relation between the dental arches demonstrated that pattern III children showed a predominance of Class III but had a fairly heterogeneous distribution of malocclusion, having 48% of children presented Class I and a almost insignificant number of 1.35% presented Class II malocclusion.[20] Thus, the possibility of diagnosis in very early stages of skeletal disharmony that are common in Class III children can play a substantial role in improving early treatment of these patients. This study aimed at identifying which cephalometric measurements has greater power to early classify patients with Class III malocclusion, differentiating those of patients with Class I malocclusion.

It was made the choice for a simplified usage of a combination of Wits,[10] McNamara[16] and Jarabak analyses,[11] in addition to some more conventional and popular standards, as the measurements of Downs.[6] While Wits[10] and McNamara[16] analyses offer an integrated linear assessment of sagittal and vertical skeletal discrepancies, also relating maxilla and mandible with the skull base; the analysis of Jarabak[11] proposes the possibility of predicting skeletal modifications resulting from growth and/or orthodontic and/or orthopedic treatment.

Just as the prevalence of Class III malocclusion displays variation between the different ethnic and racial groups,[4] the same seems to happen to the skeletal components of this malocclusion1.[5] The results of this study have not demonstrated a significantly lower length of the anterior skull base (S-N) in patients with Class III malocclusion when compared with Class I controls. The deflection angle of the skull base, produced between the anterior and posterior bases of the skull, also did not demonstrated to be reduced in patients with Class III malocclusion when compared to Class I controls. These results oppose to previous studies that suggest that skeletal abnormalities of Class III may be a reflex of alterations in skull base.

The results did not agree to previous findings that demonstrated a high prevalence of maxillary retrognathism composing the global skeletal discrepancy present in patients with Class III. Although there are reports that a hypoplasic midface and poor maxillary growth, associated with a shortened anterior skull base, are the main factors involved in the development of a Class III malocclusion in Asian children,[18] the comparative analysis between Japanese and Americans with European ancestors revealed that the mandibular prognathism was identified as an important component of Class III malocclusion in individuals of European descent.

Opposite to the expected, the SNA angle demonstrated to be increased in patients with Class III when compared to the Class I controls, however this difference was statistically significant only in stage II of cervical vertebrae maturation. The estimation of maxillary growth through the difference of values found for SNA and Co-A in stages I and II of cervical vertebrae maturation has not demonstrated substantial difference in Class I controls. However, an average increase of approximately 2° for SNA angle and 4 mm for Co-A measurement was showed in Class III patients.

Thereby, we can highlight an anterior displacement of maxillary point A in Class III patients, with a substantial increase in the related measures, although not statistically significant between the stages I and II of cervical vertebrae maturation. A possible explanation would be the fact that the point is situated in dentoalveolar region and, therefore, is subjected to anterior displacement due to the attempt of maintenance of the positive overjet in order to offset the preponderance of mandibular growth over the maxilla.

The means found for the measurements related to the length of mandibular body and effective length of the mandible showed rather significant statistical differences between Class I and Class III groups, having the means of Class III patients demonstrated to be superior to those of Class I group. Similarly, for the group of Class III patients it was observed a raise tendency in all means referent to other studied variables related to the mandibular sagittal positioning, however not in a statistically significant way.

Previous studies[17,19] showed that the mandible in patients with Class III malocclusion is found protruded, even in the early stages of the deciduous dentition, becoming more protrusive over time. The data from this study confirm this claim, demonstrating the prevalence of mandibular measurements in Class III group when compared to the Class I control group.

The Class III patients group showed statistically significant differences demonstrating a marked increase in posterior facial height and the height of the mandibular ramus when compared to the Class I control group, indicating a tendency of hypodivergent facial growth in the Class III group. The increase in posterior facial height promotes a counterclockwise rotation of the mandible with a tendency of mandibular protrusion and occlusal relation of Class III.

Thereby, the increase of posterior facial height found in patients of Class III group along with the significant increase of measures related to mandibular length justify the anterior displacement of points B and Pog with consequent establishment of highly significant statistical difference between mandibular skeletal relations SNB and NperpPog in patients of Class I and Class III groups.

These results oppose the previously obtained in similar samples of Brazilian patients where the facial vertical behavior reveals anterior facial height showing statistically significant difference, with the greater values in the group of early Class III patients than in Class I controls.[19] The widespread use in the past of Downs[6] cephalometric measures for the analysis of skeletal relations between maxilla and mandible and of these with the base of the skull could, therefore, justify previous conducts of proservating the mandibular growth in patients with normal measurements for the SNA and increased measurements to SNB angle, for example, until mandibular setback surgery could be carried out, once the analysis of the results obtained by employing these measures tend to demonstrate a apparently appropriate maxillary positioning and a mandibular protrusion.

Thus, the present study has shown, contrary to the previously demonstrated in Syrian children[18] and similar to the demonstrated in Brazilian children[19] an advanced sagittal position of the mandible in relation to the of the skull in the Class III patients in relation to the one found in Class I controls.

ANB and Wits measurements showed significant statistical differences between groups Class III and Class I patients, even in early stages. Even though Wits[14] measurements can be affected by changes in occlusal plane[5] and ANB measurements by changes in sagittal positioning of nasium point,[9] both measurements has been demonstrated to be effective for the diagnosis of Class III malocclusion.[19]

Although the mean values found for the ANB variable in Class III and Class I groups match respectively to the recognized values for Class I and Class II adults patients, these are in line with the values obtained for this variable when the same groups are evaluated in early ages.[18]

CONCLUSIONS

The results of this study led to the conclusion that Brazilian children with Class III malocclusion, when compared with Class I controls in the same early stages of cervical vertebrae maturation, present as cephalometric craniofacial characteristics: Normal anterior skull base and maxilla, anterior positioning of the mandible and increased posterior facial height.

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