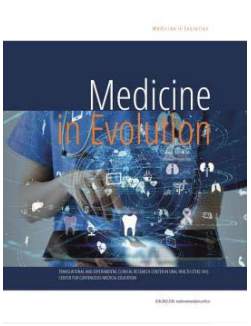
Radiographic Imaging for the Diagnosis of Patients with Class III Malocclusion: Skeletal and dental changes



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Abstract

Aim and objectives: The main purpose of this study was to reveal the main skeletal and dental changes in patients with type III Malocclusion. **Material and methods**: 42 patients were enrolled in this study (21 girls and 21 boys) aged 8 to 38 years. An analysis of the lateral cephalometric radiographs was made by manual tracing of the cephalometric points and planes. **Results**: Measurements of the main distances and angles were made. Different correlations between cephalometric parameters were made between girls and boys or between children/adolescents under and older than 17 years. Girls seem to be more affected than boys. **Conclusion**: Since many and important changes were found, starting treatment as soon as possible becomes a top priority.

Keywords: Class III malocclusion; diagnosis; radiographic imaging; dental changes; skeletal changes

INTRODUCTION

Edward Hartley Angle classified malocclusions in three different classes based on the position and relationship between the upper and lower first molars [1]. Angle Class III malocclusion is an antero-posterior dental discrepancy characterized by the mesial position of the lower first molar's buccal groove in relation to mesiobuccal cusp of the maxillary first molar [2]. The prevalence of Class III Malocclusion varies from 0.7% in Israel, 3-5% in UK, USA and Scandinavian countries to 10-15% in Turkey and Iran or 15-17% in Southeast Asian countries (for China even 20%) [1,3].

Skeletal and dental characteristic features of Class III malocclusion are retroclined mandibular incisors, anterior cross-bite, retrognathic and/or micrognathic maxilla, prognathic and/or macrognathic mandible, changes in the length or inclination of the cranial base, greater mandibular length or smaller cranial base angles [1,4].

Aim and objectives

This study aims to conduct a cephalometric analysis in patients with Class III malocclusion and identify the sagittal and vertical changes of the maxillary and mandibular parameters for this group of patients. Based on these results, a comparative analysis by age and gender was also made together with an analysis between different parameters measured in this study.

MATERIAL AND METHODS

42 patients with a class III malocclusion were included in this study. The inclusion criteria for this particular study group were age of the participants (minimum 8 years old), no previous orthodontic treatment, complete eruption of the upper and lower first molars and the presence of a dental and skeletal class III malocclusion. The patients were selected following a thorough evaluation which consisted of intraoral examination, radiographic and dental casts analyses. Informed consent was obtained for all patients involved in the study and for patients younger than 18 years old, parental permission for including in the study was reached.

All the data were collected on an examination form and then transferred into an Excel document in order to assist the statistical analysis which was done by using StataIC software, version 11 (StataCorp. 2009. Stata: Release 11. Statistical Software. College Station, TX, USA). t Student tests were used for comparing parameters from different groups and a value of $p < 0.05$ was considered statistically significant.

The lateral cephalometric radiographs were analysed by manual tracing of the cephalometric points and planes which are shown in Figure 1 and Table 1.

Figure 1. The cephalometric landmarks used in the study: Sella (S), Glabella (G), Nasion (N), Bolton (Bo), Basion (Ba), Porion (Po), Condylion (Co), Articulare (Ar), Gonion (Go), Orbitale (Or), Pterygomaxillary fissure (PTM), Posterior Nasal Spine (PNS), Anterior Nasal Spine (ANS), Point A (A), Point B (B), Prosthion (Pr), Infradentale (Id), Pogonion (Pog), Menton (Me), Gnathion (Gn)

Table 1. Cephalometric planes used in the study

Cephalometric plan	**Definition***
Anterior cranial base (Planum)	S-N
Anterior cranial base (Clivus)	S-Ba
Frankfurt horizontal	Or-Po
Palatal plane	ANS-PNS
Occlusal plane	The tip of the mesial cusp of the mandibular first permanent molar and halfway between the upper and lower incisal points
Mandibular plane	Tangent at the lower edge of the mandibular angle and Gn
A_o-B_o	Distance between projections of points A and B on the occlusal plane
Incisale superior	Longitudinal axis of the central upper incisor
Incisale inferior	Longitudinal axis of the central lower incisor
Upper anterior facial height	N-ANS
Upper posterior facial height	S-PNS
Posterior facial height	The distance in millimeters measured tangentially to the posterior border of the ascending mandibular ramus, from Ar to the mandibular plane
Anterior facial height	The distance in millimeters measured perpendicular to the palatal plane, from this one to the Me
Z line	The line from soft tissue Pogonion (Po) to the most prominent lip

**The abbreviations for the cephalometric landmarks are presented in Table 1*

Using these points and planes, we have measured several linear and angular cephalometric parameters in order to evaluate the dentoalveolar changes in the anterior segment and the skeletal implications of the malocclusion (Table 2).

Table 2. The dentoalveolar and skeletal measurements used for the cephalometric analysis

Dentoalveolar cephalometric parameters	IMPA, FMIA, id-B-M, PrA-F, IF, Ii, Z
Skeletal cephalometric parameters	SNA, SNB, ANB, Ao-Bo, Nsa-Nsp-M (Margolis angle), FMA (Tweed angle), N-S-Ba, Occlusal plane angle (Tweed-Merriefield), N-Nsa, S-Nsp, Ar-Nsp, HFP, HFA, HFP/HFA

RESULTS

The average age of our patients (21 girls and 21 boys) was 16.1 years with a minimum age of 8 and maximum of 38 years.

Parameters for all the patients involved in the study are shown in Table 3.

Table 3. Descriptive analysis of the study group with class III malocclusion

Parameter	Normal average	Average in this study	Standard deviation	Minimum	Maximum
N-S-Ba	130°	126.38	4.5	116	135
FMA	25°+/- 3°	28.14	6.58	9	44
Nsa-Nsp-M	25°	26.76	8.41	7	49
O	10°+/-3°	9.21	3.8	1	17
SNA	82°+/- 2°	78.98	3.25	72	87
SNB	78°-80°	81.02	4.75	70	90
ANB	2°+/- 2°	-2.31	3.22	-9	4
Ao-Bo	0-4 mm	-5.9	4.33	-20	1
IMPA	88°-92°	87.19	7.75	71	101
FMIA	64°-70°	65.33	8.04	51	80
Ii	130°	132.1	10.36	116	160
PrA-F	110°	100.31	10.94	73	120
id-B-M	90°	79.48	8.46	55	102
IF	105°-110°	113.31	6.92	97	128
N-Nsa	48+/- 1 mm	54.07	5.23	45	67
S-Nsp	42+/- 1 mm	48.79	3.98	40	57
Ar-Nsp	45 mm	37.29	3.8	29	45
HFA	65 mm	68.26	7.88	52	82
HFP	45 mm	48.64	7.29	34	67
HFP/HFA	0.69	0.7	0.1	0.5	0.96
Z	78°	78.7	6.48	62	94

The patient group was divided and analyzed separately based on two other criteria related to gender and age, respectively. For the first of them, the results of the descriptive analysis are included in Table 4, which presents the means, the standard deviation and the minimum and maximum values for all the parameters included in this study, separately for girls and boys.

Table 4. Descriptive analysis of the groups of girls (n=21, left) and boys (n=21, right) with Class III Angle anomaly

Parameter	Average		Standard deviation		Minimum		Maximum	
	♀	♂	♀	♂	♀	♂	♀	♂
N-S-Ba	126.14	126.62	5.07	3.96	116	121	135	134
FMA	28.1	28.2	5.8	7.42	20	9	39	44
Nsa-Nsp-M	26.62	26.9	7.65	9.3	14	7	41	49
O	9.33	9.1	3.77	3.91	1	3	17	16
SNA	78.57	79.38	3.78	2.65	72	76	87	86
SNB*	79.38	82.66	4.85	4.14	70	72	87	90
ANB	-1.38	-3.24	3.15	3.08	-9	-7	3	4
Ao-Bo*	-4.29	-7.52	3.48	4.58	-15	-20	1	1
IMPA*	89.48	84.9	7.11	7.85	75	71	101	101
FMIA*	62.86	67.81	8.22	7.22	51	59	78	80
Ii	133.1	131.1	10.96	9.88	116	117	160	148

PrA-F*	96.81	103.81	7.39	12.84	82	73	109	148
id-B-M*	82.1	76.86	7.84	8.42	70	55	102	93
IF*	110.81	115.81	6.56	6.49	97	104	123	128
N-Nsa*	55.76	52.38	6	3.76	46	45	67	62
S-Nsp*	50	47.57	4.34	3.26	41	40	57	52
Ar-Nsp	38.05	36.52	4.19	3.3	29	40	45	52
HFA	69.14	67.38	8.14	7.7	52	53	82	82
HFP	48.14	49.14	7.86	6.84	34	41	61	67
HFP/HFA	0.69	0.71	0.11	0.1	0.5	0.56	0.87	0.96
Z*	76.38	81	4.97	7.07	62	70	83	94

*p < 0.05

The next criterion taken into study refers to the age category. For this analysis, the group of patients with Angle class III malocclusion were divided in two subgroups: subjects under 17 years of age (in which it is considered that there is still a possibility of growth) and over 17 years (with little probability of growth). The results of the descriptive analysis for these age groups can be found in Table 5, which presents the averages, the standard deviation and the minimum and maximum values for all the parameters.

Table 5. Descriptive analysis of the group of patients younger than 17 years old (n=29) and older than 17 years old (n=13)

Parameter	**Average**		**Standard deviation**		**Minimum**		**Maximum**	
	< 17 y	> 17 y	< 17 y	> 17 y	< 17 y	> 17 y	< 17 y	> 17 y
N-S-Ba	126.66	125.77	4.62	4.32	116	122	134	135
FMA	29	26.23	6.24	7.15	18	9	44	37
Nsa-Nsp-M	27.38	25.38	8.22	9	14	7	49	44
O	9.34	8.92	4.13	3.07	1	3	17	14
SNA	78.52	80	3.25	3.14	72	76	87	86
SNB	80.28	82.69	4.82	4.31	70	74	87	90
ANB	-1.93	-3.15	3.47	2.48	-9	-7	4	2
Ao-Bo	-5.34	-7.15	4.06	4.83	-15	-20	1	-2
IMPA	86.62	88.46	7.49	8.46	72	71	101	101
FMIA	65.45	65.08	8.06	8.33	51	53	80	79
Ii	133.07	129.92	10.6	9.84	116	116	160	145
PrA-F	98.52	104.3	10.18	11.91	73	82	114	120
id-B-M	78.86	80.85	7.98	9.65	67	55	102	94
IF	112.28	115.62	7.24	5.75	97	107	128	125
N-Nsa	53.72	54.85	5.48	4.76	45	48	67	62
S-Nsp*	47.9	50.77	4.07	3.06	40	46	57	57
Ar-Nsp*	36.52	39	3.95	2.89	29	32	45	43
HFA	67.79	69.31	7.41	9.08	52	53	82	82
HFP*	46.41	53.62	6.26	7.17	34	41	61	67
HFP/HFA	0.69	0.75	0.1	0.1	0.5	0.62	0.92	0.96
Z	78.97	78.08	6.41	6.85	62	70	92	94

*$p < 0.05$

The significant statistically correlations were marked in Tables 4 and 5 taking into account a value of $p < 0.05$.

DISCUSSIONS

The lateral cephalometric radiographs analysis of the patients enrolled in this study highlighted in some cases that the class III Malocclusion involves changes within the skull base, and for other cases, in addition to this, a lot of maxillary/mandibular disorders including the dento-alveolar segment have been found leading to compensatory or aggravating conditions.

The descriptive analysis revealed the following main findings:

- the value of the N-S-Ba angle is reduced leading to an anterior position of the mandible in relation to the skull base;
- the SNA angle is less than 80° (which reveals a retrognathic maxilla) and the SNB angle is higher than 78° (which demonstrates the presence of a prognathic mandible). These findings correlate with the negative values of the ANB angle and the Ao-Bo distance. In the comparative analysis by gender, a higher value of the SNB angle was observed in girls ($p < 0.05$) in addition with the Ao-Bo distance, which also presents a higher negative value in girls than in boys ($p < 0.05$);
- FMA (Tweed angle) medium value was higher than normal advocating for greater vertical changes in the anterior sector and, at the same time, for the posterior rotation of the mandible. This result correlates with the increased value of the bispino-mandibular angle (angle B).
- the increased values of the anterior-superior facial height (N-Nsa) and of the posterior-superior height (S-Nsp). Also, the value of the Ar-Nsp distance was calculated in order to analyse the changes in the posterior facial height because this parameter also brings additional information about the anterior position of the maxilla on the skull base. The value of this distance was increased for the study group.
- the inclination of the occlusal plane with reference to the Frankfort Horizontal plane showed a reduced value;
- assessments related to changes in the dento-alveolar in the sagittal plane show an interesting evolution in patients with a class III malocclusion. In the maxilla, the changes in the two sectors appear in the opposite direction, the retroalveolia being associated with the protrusion, which means that the alveolar process aggravates the changes, and the teeth tend to compensate for the deficit. The lower arch presents more constant characteristics: the average obtained for the study group demonstrates the presence of inferior retroalveolodontia, which can be interpreted as a compensatory phenomenon in cases with sagittal inocclusion.
- the analysis of the facial profile Z angle reveals normal limits for the study group, which is not characteristic of a class III malocclussion. However, taking into account, the increase in FMA and, on the other hand, the anterior position of the mandible, the two effects neutralize the value of the Z angle within normal limits. The comparative analysis by gender reveals differences with a statistically significant probability ($p=0.0188$); thus, in girls, the average Z angle has significantly higher values (81°) compared to boys (76°).

Usually, in type class III Malocclusion the SNB angle is higher than SNA angle. We found the same results in our analysis. There are also other studies that confirm this finding [5]. In general, the cephalometric parameters that define the position of the maxilla and mandible in relation to the skull base (SNA and SNB angles) were different compared to normal. These findings are sustained by many studies [6, 7, 8].

The statistical correlations of our analysis revealed the following findings:

- SNB > SNA is a trend among these patients;

- a strong relation between angles Nsa-Nsp-M and FMA, which means an equal involvement of the maxillary and mandibular to the facial hypodivergent skeletal pattern;
- no correlation was found between changes in the sagittal plane of the upper and lower alveolar process, as well between upper and lower incisors relationship;
- the ratio of the facial heights (HFP/HFA) is in relation with the sagittal position of the mandible (SNB) as well as with the position of the lower incisors (IMPA).

CONCLUSIONS

We can strongly conclude that**:**

- vertical changes of the maxillary bases were higher in the anterior sector;
- decreasing of the sphenoidal angle leads to a sagittal intermaxillary gap;
- upper facial height was higher, especially in boys and over 17 years old;
- girls seem to be more affected than boys.
- the analysis of the cephalometric parameters must always be interpreted in the individual context of each case because the function can greatly influence the changes in the skeletal or dento-alveolar sectors.

Because of so many changes present in patients with type III malocclusion starting the orthodontic treatment as soon as possible becomes a priority.

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