Soft Tissue Profile of Skeletal Class III Malocclusion among Albanian Patients Seeking Orthodontic Treatment

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Abstract

The aim of this study was to analyse by means of Holdaway cephalometric soft tissue profile of skeletal class III patients and to detect possible differences related to gender.

100 patients equally divided in 2 groups according to skeletal malocclusion group I (skeletal class I) group II (skeletal class III) with mean age 11.6 and median 12 years were involved in our study. Holdaway cephalometric analysis was used for the evaluation of soft tissue profile.Independent samples t test was used.

For the cephalometric parameters such as facial angle, superior sulcus depth, subnasale to H plane, basic upper lip thickness and upper lip strain there were no significant differences regarding the classes. While for the nose prominence, skeletal convexity, H angle, lower lip to H plane, inferior sulcus, the differences regarding the classes are significant. Among the skeletal class III group, a gender difference was found only for Inferior sulcus to H plane.

Skeletal class III patients show soft tissue profile concavity when compared with skeletal class I patients.

Clinical article (J Int Dent Med Res 2023; 16(2): 650-655)

Keywords: Cephalometric, malocclusion, Soft tissue profile, skeletal class III.

Received date: 28 December 2023 **Accept date:** 22 January 2023

Introduction

Malocclusions have a great impact on the soft tissue profile[1]. Park and Burstone statement that facial aesthetic requires consideration of soft tissues factors in addition to hard tissue structures emphasizes the necessity to thoroughly diagnose without underestimating the soft tissue profile[2]. Especially for patients with a skeletal class III malocclusion soft tissue profile is a serious concern [3]. Smaller maxillary length from age 8-15 years, maxillary retrusion and protrusive incisors are among characteristics of skeletal class III patients [4]. The concave profile of individuals with skeletal class III is a common finding of many researchers [3]. Wassertein found significant differences in soft tissue angle ANB and ANPog between Angle class I and class III malocclusion.[5]

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Timming is an important concept in orthodontic treatment since it enables growth modification in case of skeletal III malocclusion [6]. Furthermore, it was established that the continuing growth worsens the skeletal discrepancy. While considering features of class III skeletal growth, that is longer and lasts even after pubertal growth spurt [7]during treatment planning it is important to consider as well soft tissue growth that as reported from Nanda[8] especially in girls during the age interval 10-15 years when most of orthodontic treatment are performed coincides with changes in soft tissue profile.

A literature search seems not to find agreement on the relationship between skeletal and soft tissue profile. It was previously described an association between some skeletal cephalometric parameters such as sagittal relations between maxilla and mandible namely ANB angle, convexity of A point, lower facial height with the soft tissue profile [9,10].

Burstone suggested that variations in the soft tissue thickness does not allow a close relationship with the corresponding hard tissues[11]. According to Subtelny not all parts of the profile directly follow the underlying bone tissue[12].

Cephalometric analysis was proven to be a very reliable way for orthodontic diagnosis, enabling not only the analysis of skeletal and dental components but also the soft tissue profile[13,14].

The objective of this study was to evaluate by means of Holdaway cephalometric analysis the soft tissue profile of patients with skeletal class III malocclusion as well as gender related changes in a sample of Albanian patients seeking orthodontic treatment

Materials and methods

Ethics approval of research

This cross-sectional research was approved by the Ethic Council of Albanian University (date 07/04/2022, number 261).

50 skeletal class I and 50 skeletal class III patients (25 girls and 25 boys in each of skeletal class) seeking orthodontic treatment at Albanian University, Department of Dentistry, Faculty of Medical Science were selected for this study. In the skeletal class III group patients with ANB angle negative according to Steiner cephalometric analysis were selected, while the skeletal class I patients ANB angle $0\text{-}4^0$. Inclusion criteria in the study were no previous orthodontic treatment, no congenital deformity, Albanian ancestry.

All patients requiring orthodontic treatment at the University clinic that agree to undergo orthodontic treatment, before the start of the treatment, sign an informed consent, which includes permission to use their orthodontic data for research purposes.

All lateral x-rays were taken from the same experienced operator using the same device (Kodak 8000C Digital Panoramic and Cephalometric System, Carestream Health, Inc., Rochester, NY, USA), 75 kV power exposure time 0.80 sec. Placement of the patients in device was standing by fixing head to allow the sagittal plane of the head to create a 90^0 angle to the x-ray path and the Frankfort Horizontal Plane (FHP) was parallel to the horizontal plane. Patients were instructed to occlude in a centric occlusion and to maintain the lips in rest without straining. Taking the x-rays with the same device and proportions avoid the need to use a correction for magnification.

Manual cephalometric tracing was performed by one of the authors E.K on acetate paper using 0.5 mm lead pencil. Definition according to Holdaway was used to determine cephalometric landmarks and construct lines and measurement (Figure1,2). Using Ormco Cephalometric Protractor/ Tracing Template (Ormco Corporation, Brea California, USA) 2 angular measurements were measured to the nearest 0.5^0 and 9linear to the nearest 0.5mm.
3 weeks after initial tracing 20 randomly selected radiographs were traced and measured by the same investigator who performed the first measurement.

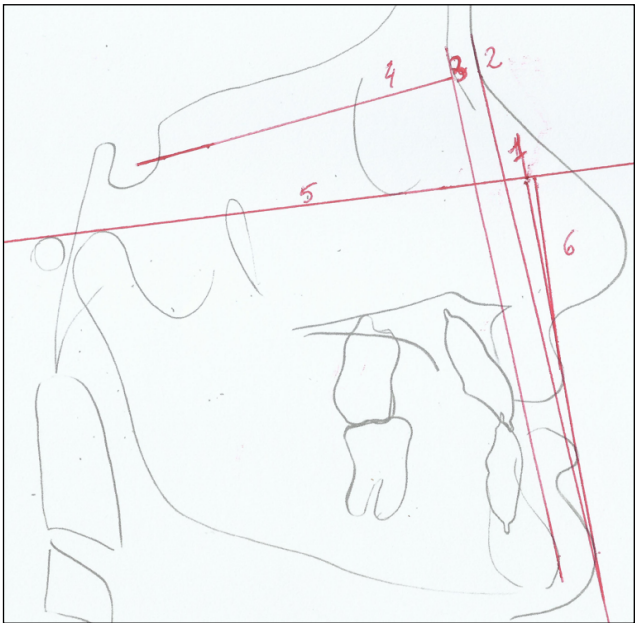

Figure 1. Lines used in Holdaway cephalometric analysis. 1.The H plane or harmony line drawn tangent to the soft tissue chin and the upper lip, 2. Soft tissue facial line from soft tissue chin overlying Ricketts' suprapogonion, 3. The hard tissue facial plane, 4. The Sella-Nasion line, 5. The Frankfort horizontal plane (FH), 6. A line running at a right angle to the FH down tangent to the vermilion border of the upper lip.

Based on Dalhberg approach and recomendation on calculation the measurement of sistematic error, the coeficient of error was calculated for each the cephalometric measurements[15].

The statistical program used was the Statistical Package for the Social Sciences (SPSS), Version 26 (IBM® Inc, New York, USA). The mean and median, standard deviations (S.D) and standard error (S.E) were used for each of cephalometric parameters. Independent sample

t-test was performed to test the significance of the differences between the means between classes and gender in each of the class. The levels of significance tested was p=0.01.

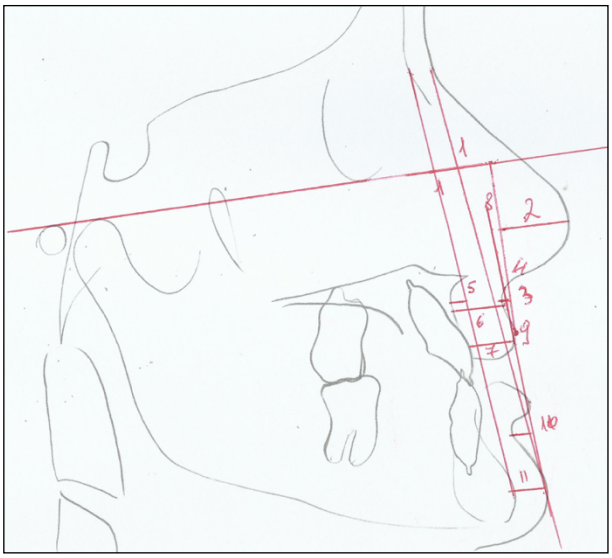

Figure 2. Cephalometric parameters used in Holdaway analysis. 1. Soft tissue facial angle 2. Nose prominence (mm), 3. Superior sulcus depth (mm), 4. Subnasale to H plane (mm), 5. Convexity at A point (mm), 6. Basic upper lip thickness (mm), 7. Upper lip strain (mm), 8. H angle, 9. Lower lip to H plane (mm), 10. Inferior sulcus to H plane (mm), 11. Soft tissue chin thickness (mm).

Results

100 patients with mean age 11.6 and median 12 years. The minimum age was 7 and maximum 15 years old. From 100 patients, half of them were female and half belongs to the class I.

Cephalometric parameters	r
Facial angle	0.96
Nose Prominence	0.45
Superior Sulcus Depth	0.40
Subnasale to H plane	0.98
Convexity at A	0.52
Basic Upper Lip Thickness	0.91
Upper Lip Strain	0.85
H angle	0.74
Lower Lip to H plane	0.68
Inferior Sulcus to H plane	0.91
Soft Tissue Chin Thickness	0.99

Table 1. Correlations between first and second measurements.

Error of the method results as reported in Table 1. The highest correlation was found for soft tissue chin thickness 0.99 while the lowest 0.40 for superior sulcus depth.

Cephalometric parameters	Mean	S. D	S. E
Facial angle °	89.74	4.14	0.43
Nose Prominence	10.72	7.05	1.73
Superior Sulcus Depth	-8.87	6.28	2.44
Subnasale to H plane	-3.98	7.18	4.48
Convexity at A	0.54	4.35	2.48
Basic Upper Lip Thickness	21.84	4.49	1.11
Upper Lip Strain	18.77	4.27	1.27
H angle °	10.92	4.14	1.79
Lower Lip to H plane	-0.57	2.86	1.50
Inferior Sulcus to H plane	5.28	3.26	1.40
Soft Tissue Chin Thickness	17.34	3.62	0.85

Table 2. The mean, standard deviation and standard error for cephalometric measurements.

Cephalometric parameters	Class	Mean	S. D	P-value
Facial angle °	1	89.072	3.79	0.111
	3	90.4	4.43	
Nose Prominence	1	13.08	6.02	0.001*
	3	8.36	7.35	
Superior Sulcus Depth	1	-8.10	6.01	0.222
	3	-9.64	6.56	
Subnasale to H plane	1	-1.78	6.55	0.002*
	3	-6.17	7.25	
Convexity at A	1	2.95	3.16	0.000*
	3	-1.87	4.08	
Basic Upper Lip Thickness	1	21.86	4.18	0.965
	3	21.82	4.86	
Upper Lip Strain	1	18.71	4.57	0.879
	3	18.84	4.04	
H angle °	1	13.03	3.84	0.001*
	3	8.80	3.32	
Lower Lip to H plane	1	0.42	2.92	0.001*
	3	-1.55	2.50	
Inferior Sulcus to H plane	1	7.02	2.66	0.001*
	3	3.54	2.89	
Soft Tissue Chin Thickness	1	18.14	3.64	0.027
	3	16.54	3.48	

Table 3. The comparison of the mean for each of the Cephalometric parameters between the groups.

The table 2 shows the mean, S.D and S.E for each of the Cephalometric parameters considered in the study. The comparisons of means for each of the cephalometric parameters between two skeletal groups are presented in the Table 3.

As it resulted from statistical analysis for the following cephalometric parameters such as facial Angle, Superior sulcus depth, subnasale to

H plane, basic upper lip thickness and Upper lip strain, there is not any significance differences on mean. While for the other parameter as the nose prominence, skeletal convexity, H angle, lower lip to H plane, inferior sulcus, there is a significant difference between the means for cephalometric parameters according the class. (Table 3).

Cephalometric parameters	Gender	Mean	S. D	p value	Gender	Mean	S. D	p-value
Facial angle °	F	88.6	3.7	0.376	**M**	89.9	4.6	0.427
	M	89.6	3.9		**F**	90.9	4.3	
Nose Prominence	F	13.1	6	0.978	**M**	7.2	7.6	0.251
	M	13.1	6.2		**F**	9.6	7	
Superior Sulcus Depth	F	-7.5	6.9	0.455	**M**	-10.7	6	0.245
	M	-8.7	5.1		**F**	-8.6	7	
Subnasale to H plane	F	-0.8	6.9	0.27	**M**	-6.7	7.6	0.632
	M	-2.8	6.2		**F**	-5.7	7	
Convexity at A	F	2.5	2.7	0.276	**M**	-2.2	5.1	0.546
	M	3.4	3.5		**F**	-1.5	2.9	
Basic Upper Lip Thickness	F	22.6	4.4	0.191	**M**	23.1	5.6	0.061
	M	21.1	3.9		**F**	20.5	3.7	
Upper Lip Strain	F	19.6	4.8	0.19	**M**	19.8	3.5	0.112
	M	17.9	4.3		**F**	17.9	4.4	
H angle °	F	13.4	4	0.465	**M**	8.8	3.4	0.96
	M	12.6	3.7		**F**	8.8	3.3	
Lower Lip to H plane	F	-0.1	3.1	0.247	**M**	-2.2	2.7	0.051
	M	0.9	2.7		**F**	-0.9	2.2	
Inferior Sulcus to H plane	F	7.1	3	0.75	**M**	2.5	2.8	0.008*
	M	6.9	2.3		**F**	4.6	2.6	
Soft Tissue Chin Thickness	F	18	3.7	0.748	**M**	16.4	3	0.713
	M	18.3	3.6		**F**	16.7	4	

Table 4. Gender related changes as according to skeletal class.

Regarding the gender differences between skeletal class I and III female and male patients the results are given in Table 4. No gender differences were noted among the skeletal class I patients.

There is a significance difference for the Cephalometric parameter of Inferior sulcus to H plane regarding the gender (2.5 mm in male versus 4.6 mm in female).

Discussion

The objective of this study was to evaluate soft tissue profile of skeletal class III malocclusion and gender related changes in a sample of Albanian patients seeking orthodontic treatment.

Nowadays several methods such as computed tomography (CT) scanning, magnetic resonance imaging (MRI) can be used to assess facial soft tissue thickness. It was decided to use the Holdaway analysis has been used as it is dedicated to soft tissues only thus avoiding the extra radiologic examination since cephalometric analysis is a routine examination for orthodontic patients.

Skeletal class III patients profile compared to skeletal class I is different according to the results of this study. This general conclusion is in line with previous research findings that in addition to skeletal changes concluded that soft tissues turned out to be factors that contribute to the features of skeletal class III maloclussion[3]. Saglam et al in their research looked at changes in soft tissue profile in children 9-12 years concluded that during growth the face become less convex [16]. The soft tissue facial angle did not show significant change between the 2 groups. Referring to Holdaway the soft tissue chin point serves as a better measurement for the chin prominence comparing to hard tissue point due to the variety of soft tissue chin thickness[13]. Thus, according to the mean values in this study seems that our sample of skeletal class III patients does not show chin prominence when compared to control group.

The soft tissue thickness growth from 7-18 years is due to the skeletal growth[8]. The skeletal class III group compared to class I showed no significant changes for soft tissue chin thickness means, which had an impact on soft tissue facial angle measurement changes since this line passes at soft tissue pogonion were soft tissue chin thickness is measured. In his longitudinal cephalometric study of soft tissue profile growth in vertical dimension[17] found compensations according to skeletal discrepancy. Thus, referring to previous [17] our sample of class III patients seems to be normodivergent. It might seem not in agreement with [3,18] stating their samples were hyperdivergent. Certainly, this conclusion should not be generalized as a feature of skeletal class III malocclusion among Albanian patients. The inclusion criteria for skeletal class III sample was according to ANB angle without further details regarding hard tissue measurements.

In his longitudinal report of soft tissue profile changes Bishara beside suggesting that H angle is age-dependent also established for 5-17 years old children a range 13.5(±3.9)[19].

According to Thilander lip profile follows skeletal changes during growth and this progressive loose of convexity may end up in a concave profile [20]. The H angle according to Holdaway measures the prominence of upper lip. Retrusive upper lip was found in the skeletal class III patients. This finding is in agreement

with Kerr 1987 who also noted a smaller H angle in skeletal class III patients [21].

Changes in lip thickness related to growth described that the increase was uniform from 7-18 years old [8]. There were no significant changes regarding upper lip thickness and strain. An explanation of such finding may be related to the proclination of maxillary incisors in skeletal class III malocclusion[22] and the fuller upper lip in individuals with maxillary incisor protrusion[23].

Skeletal profile convexity showed significant changes between the two groups. Class I patients had a mean of 2mm while Class III patients had a negative value (-1.87mm). To find a negative value of skeletal profile convexity is not a surprising fact if the sample is formed with skeletal class III patients who been showed to have a smaller maxillary length from age 8-15 years, maxillary retrusion and protrusive incisors [3.4]. In line with previous research among soft tissue characteristics of skeletal class III malocclusion is the prominent lower lip [3.21].

It was suggested that hard tissue point A and B are closely correlated with the position of soft tissues A and B point [24]. Inferior sulcus according to Holdaway is measured as a line from soft tissue B point to H Line. While soft tissue B pointed is strongly correlated to hard tissue B point [24] the change between two groups arise from retrusion of upper lip in skeletal class III patients since the H line passes through. We did not find any significant change regarding superior sulcus depth between skeletal class I and III.

The reduced sagittal development of the nose was found in a study from McWilliams[25]. Reduced nose prominence was also noted in skeletal class III patients compared to control group[21].

Sexual dimorphism in both soft and hard tissue growth was reported earlier [8.20.26]. In a study of skeletal class III malocclusion with 107 individuals Caucasians mean age 14.6±2.2 years was reported dominance of mandibular protrusion without gender differences in soft tissue profiles [18]. The only difference was found regarding inferior sulcus. While evaluating Italian children according to sagittal skeletal class malocclusion Gibelli also noted changes in soft tissue thickness in mid and low face [27].

To the best of our knowledge this study is the first to report data regarding skeletal malocclusion features among Albanians. This study is not without limitations. Although this study did not aim to study differences in growth of soft tissue we do consider as a limitation the rather small sample that does not allow for grouping patients according to skeletal age. Second, comparing results obtained especially regarding soft tissue profile ethnicity is known to play an important role on soft tissue morphology requires similar studies [20]. Few studies with sample of Caucasian ethnicity were Albanians belong, are available mostly studying adult with balanced faces and occlusion. Furthermore, none of them used Holdaway cephalometric analysis.

Conclusions

Soft tissue profile concavity, retrusive upper lip and protrusive lower lip profile deteriorates aesthetics and harmony of individuals with skeletal class III malocclusion. With regard to gender conclusions of this study are in line with previous studies reporting changes in the lower facial third.

Acknowledgement

All authors have made substantive contribution to this study, and all have reviewed the final paper prior to its submission.

This publication was financially supported by 'Albanian University' Fund for Scientific Reasearch.

Declaration of Interest

There is no conflict of interest regarding the publication of the present study

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