DENTAL MEDICINE

The relation between mandibular symphysis and the Angle class in orthodontic treatment

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Abstract

Objectives. Facial perception depends on the different components of the face. The chin is a striking anatomical structure in the individual's identity and mandibular symphysis (MS) shape influences the adjacent soft tissue, determining facial harmony. In lateral cephalometry, the MS corresponds to the image of the mandibular body in its anterior curvature. It shape, inclination and thickness provide valuable information for orthodontic diagnosis and prognosis. Since facial features are associated with malocclusions, the present investigation aims to relate the height, thickness and inclination of the MS using Angle's Class.

Methods. 495 lateral incidence cephalograms of an orthodontic population were analyzed using a previously developed and tested software. The sample was randomly selected and the height, thickness and inclination of the MS were measured. The values were statistically analyzed ($p \leq 0.05$).

Results. The distribution according to Angle's Class was 48.9% for Class I, 34.7% for Class II Division 1, 7.4% for Class II Division 2 and 8.9% for Class III. The MS height did not´t show significant differences between the three dental classes. The MS thickness was significantly increased in Class II Division 2 and Class I subjects ($p = 0,037$). The MS inclination was significantly less in Class III subjects when compared to Class I and Class II Division 1 ($p \leq 0.001$).

Conclusions. The MS presented variations, which may be associated with a natural compensation against malocclusion, influencing the position of the teeth and their relationship with the other dento-craniofacial structures and with consequences on the facial harmony.

Keywords: mandibular symphysis, chin, angle class, orthodontic treatment, facial aesthetics

Background and aims

The perception of the face is based on the recognition of the different subcomponents of the face [1,2]. Among the most relevant anatomical areas for addressing orthodontic problems, the mandible stands out due to the importance that this skeletal structure plays in the composition of facial balance and also the aesthetic perspective [3-5].

The term symphysis is reserved to define a certain type of suture or bone joint with special characteristics, such as immobility, which distinguish it from other joints in the body. Anatomically, it is the structure that establishes the union between the two halves of the mandibular bone in the anterior region, coinciding with the sagittal plane [6,7]. It is present in the lower 1/3 of the face and, therefore, it is relevant in terms of aesthetics and facial harmony [1,4,8]. In harmonious faces, the lower third is equivalent in size to the middle third and the upper third [9-11]. Symphysis, mentum, chin, mentonian symphysis, mental symphysis and chin

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bone are some of the various designations used in the literature for this structure.

Lateral teleradiography and the respective cephalometry are one of the oldest and most important elements of study in orthodontics [12,13]. Cephalometric analysis allows us to assess the relationship between the different craniofacial structures, fundamentally with regard to their shape, dimension and position. In lateral cephalometry, the mandibular symphysis (MS) corresponds to the anterior region of the mandibular bone, which serves as the base for the incisor teeth. It presents itself in an image well delineated by the cortical bone that demarcates it with a very characteristic "drop" shape. This structure corresponds to the image of the mandibular body in its anterior curvature.

When analyzing the MS, we must take into account its shape, dimension and inclination, as these provide important information for the orthodontic diagnosis and prognosis of the treatment plan. In this context, the main objective of the study was to relate the height, thickness and inclination of the mandibular symphysis using the Class of Angle. As secondary objectives, this study intends to evaluate factors that influence mandibular symphysis morphology, as well as to establish the importance of incorporating symphysis analysis in orthodontic treatment.

Methods

The present study is observational, cross-sectional, exploratory and descriptive.

Three thousand randomly selected individuals from a population of orthodontic cases from an orthodontic clinic in Northern Portugal were analyzed. From these, we obtained a final sample of 495 individuals who met the inclusion criteria.

Inclusion criteria: patients with initial records that: have not been subjected to any type of orthodontic treatment; protocol photographs; panoramic radiography and lateral teleradiography of the face; orthodontic exam. The lateral cephalograms had to have the mandibular symphysis clearly visible.

Exclusion Criteria: poor definition and quality of teleradiography; no cephalometric tracing; major oral rehabilitations; edentulous patients; absence of upper and/or lower central incisors.

The DOLPHIN IMAGING® program was used for observation and calibration of teleradiographies and execution of the cephalometric tracing (according to Ricketts) and the MB RULER® program for measuring angles (in degrees - º) and distances (in millimeters - mm). These values were properly filled in an Excel® document for further statistical analysis.

The symphysis variables analyzed were:

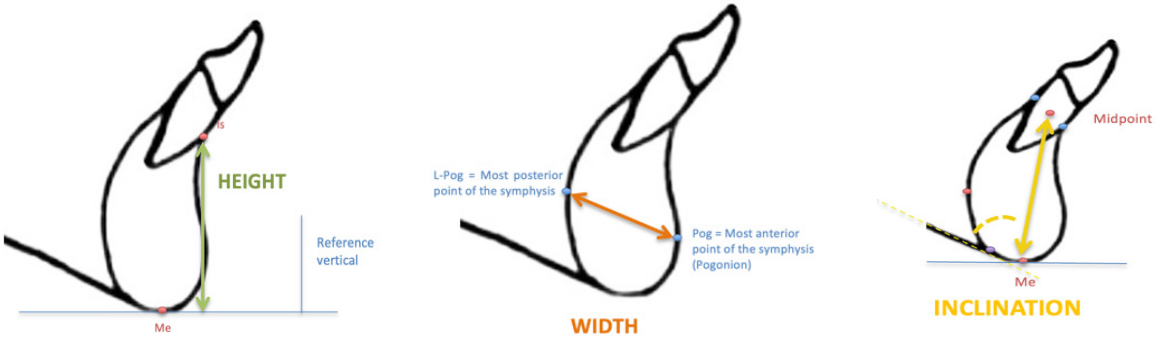
- Height: vertical distance between point Is and the horizontal line that passes through Mentum Point (Me).
- Width: distance between points Pogonion (Pog) and the most posterior point of the symphysis (L-Pog).
- Inclination: Angle that the line [Midpoint-Mentum Point] makes with the mandibular plane.

Figures 1, 2 and 3 show how the symphysis variables were measured.

Statistical analysis was performed using IBM® SPSS® version 25.0. The ANOVA methodology was used to compare the measures, and when significant differences were detected, Tukey's multiple comparison tests were used. The decision rule used consisted of detecting significant statistical evidence for probability values less than 0.05.

Ethical considerations: to carry out this study, facial cephalograms already existing in a clinical file were used, so the present study does not present any risk, since nothing was carried out in patients. During the research, all the ethical rules described in the current legislation were considered, namely regarding the treatment and storage of data, where the confidentiality of all information was guaranteed, and the data used are not identifiable to the patient.

Taking these facts into account, approval was requested from the Ethics Committee, from which a positive response was obtained.



Figures 1, 2 and 3. Symphysis variables (1-Height, 2-Width, 3- Inclination).

Results

Statistical analysis of measurement error: to verify the degree of systematic difference between the measurements of the pair by the same examiner at two times, preceded by verification of the normal distribution, the t-student test for paired samples was used in 10% of a sample randomly selected from the set of 495 valid cases. The results are shown in table I. According to the results of the t-student test for paired samples, there are no significant differences in the mean values of the measurements at the two times.

Table I. Student t-test results for measurement error evaluation.

	t	gl	p value	Result
MS height	1.934	59	0.058	Not significant
MS width	-0.143	59	0.887	Not significant
MS inclination	-0.300	59	0.201	Not significant

The total sample consists of 495 cases, of which 140 are male (28.3%) and 355 are female (71.7%), aged between 7.06 and 68.02 years.

Individuals from all Angle Classes were present in the sample: 224 Class I subjects (45.3%), 159 Class II Division (Div.) 1 subjects (32.2%), 34 Class II Div.2 (6.9%), 42 Class III individuals (8.5%) and 36 undefined individuals (it was not possible to define their dental class).

Table II presents the sample characterization data in relation to the symphysis measures variables according to the Angle Class.

To compare symphysis measurements according to Angle Class, the ANOVA methodology was used to compare mean values between groups, and when significant differences were detected, Tukey's multiple comparison tests were used. The results are summarized in table III.

Table III. ANOVA results according to Angle Class.

	gl	F	p value	Result
MS height	(4.488)	2.821	0.025	Significant
MS width	(4.488)	2.691	0.031	Significant
MS inclination	(4.488)	10.452	<0.0001	Significant

Tukey's multiple comparison tests for significant results are shown in table IV.

From the results shown in table IV, significant differences were detected in the mean values in the pairs marked with (*). The profile graphs in figures 4, 5 and 6 illustrate these results.

The height of the symphysis did not show significant differences between the three dental classes.

The symphysis width was significantly greater in Class II Div.2 subjects.

The symphysis inclination was significantly lower in Class III subjects when compared to Class I subjects, and Class II Div.1 individuals had the highest MS inclination value.

Table II. Summary statistics for measures according to Angle Class.

	Angle Class	N	Mean	Standard Dev.	Min.	Max.
MS height	Class I	226	31.49	3.59	21.46	43.13
	Class II Div.1	159	31.31	3.74	22.68	38.69
	Class II Div.2	34	31.81	2.97	23.48	38.82
	Class III	41	31.91	4.32	24.64	40.86
	Undefined	35	33.55	3.96	25.25	42.07
	Total	495	31.64	3.72	21.46	43.13
MS width	Class I	226	14.05	1.85	8.82	23.56
	Class II Div.1	159	14.18	1.95	9.72	19.78
	Class II Div.2	34	15.05	1.64	11.12	18.56
	Class III	41	14.26	2.20	10.22	23.36
	Undefined	35	13.65	1.92	10.64	18.86
	Total	495	14.15	1.92	8.82	23.56
MS inclination	Class I	226	76.00	5.46	62.44	89.13
	Class II Div.1	159	77.61	6.82	26.96	89.03
	Class II Div.2	34	73.95	5.24	66.08	87.57
	Class III	41	71.57	5.33	62.00	82.80
	Undefined	35	74.05	6.08	56.85	84.39
	Total	495	75.87	6.18	26.96	89.13

Table IV – Multiple comparisons according to the Angle Class.

	(I) Angle Class	(J) Angle Class	mean difference (I-J)	p value
MS height (mm)	Class I	Class II Div.1	0.17119	0.992
		Class II Div.2	-0.32445	0.989
		Class III	-0.42805	0.960
		Undefined	-2.06558*	0.019
	Class II Div.1	Class II Div.2	-0.49564	0.954
		Class III	-0.59925	0.887
		Undefined	-2.23677*	0.011
	Class II Div.2	Class III	-0.10361	1.000
		Undefined	-1.74113	0.289
	Class III	Undefined	-1.63753	0,305
MS width (mm)	Class I	Class II Div.1	-0.12469	0.970
		Class II Div.2	-0.99735*	0.037
		Class III	-0.20609	0.969
		Undefined	0.40519	0.769
	Class II Div.1	Class II Div.2	-0.87266	0.111
		Class III	-0.08140	0.999
		Undefined	0.52988	0.570
	Class II Div.2	Class III	0.79126	0.381
		Undefined	1.40254*	0.020
	Class III	Undefined	0.61128	0.632
MS inclination (°)	Class I	Class II Div.1	-1.60818	0.071
		Class II Div.2	2,.04689	0.336
		Class III	4,.42607*	0.000
		Undefined	1.95096	0.373
	Class II Div.1	Class II Div.2	3.65507*	0.011
		Class III	6.03425*	0.000
		Undefined	3.55914*	0.013
	Class II Div.2	Class III	2.37918	0.421
		Undefined	-0.09593	1.000
	Class III	Undefined	-2.47511	0.371

*significant differences for a 5% significance level.

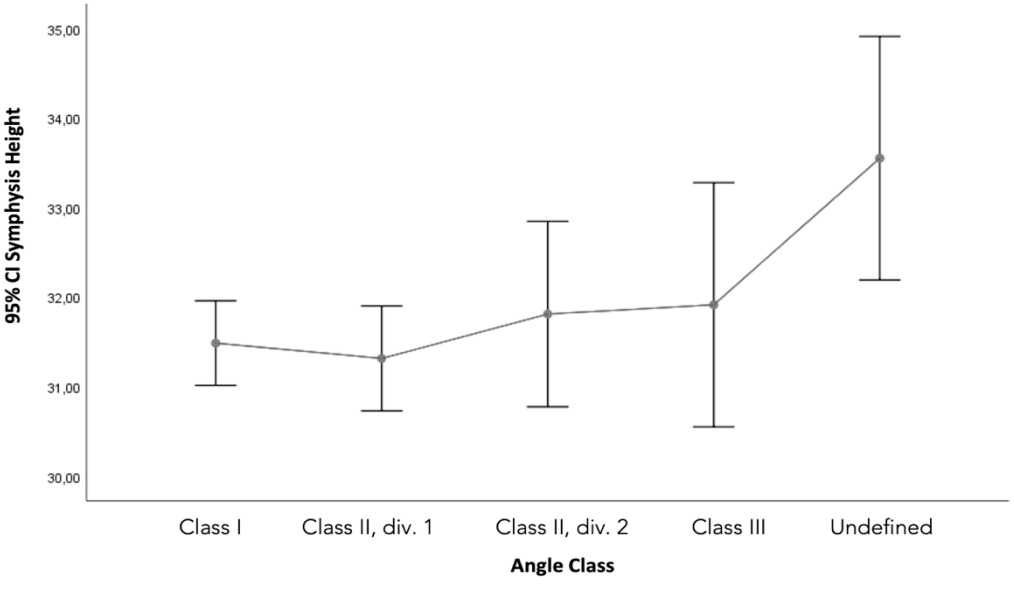


Figure 4. Mean values of symphysis height and respective 95% CI according to Angle's Class.

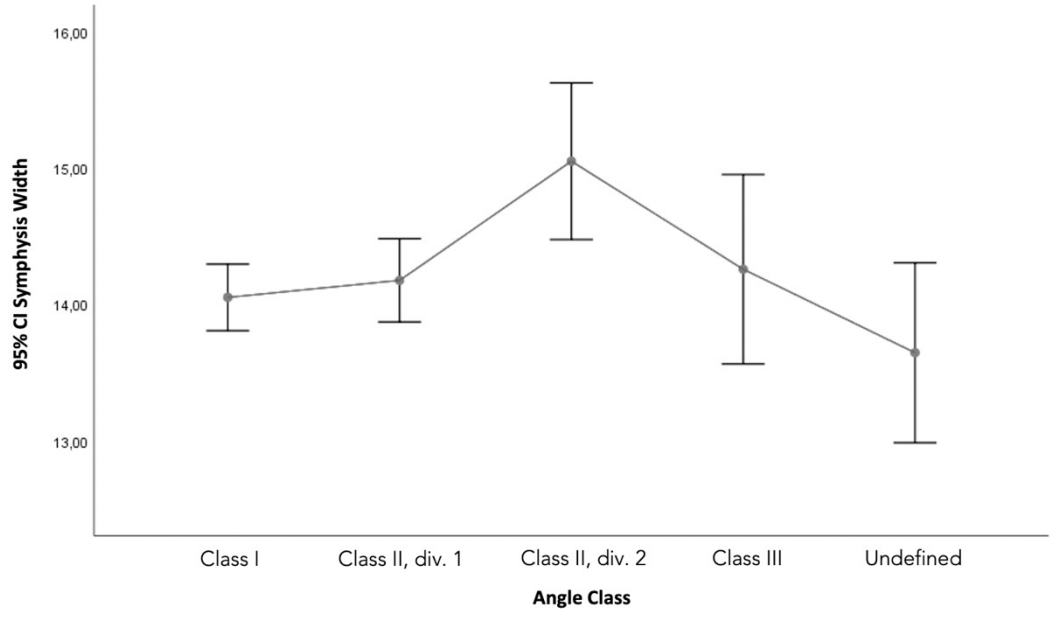


Figure 5. Mean values of symphysis width and respective 95% CI according to Angle's Class.

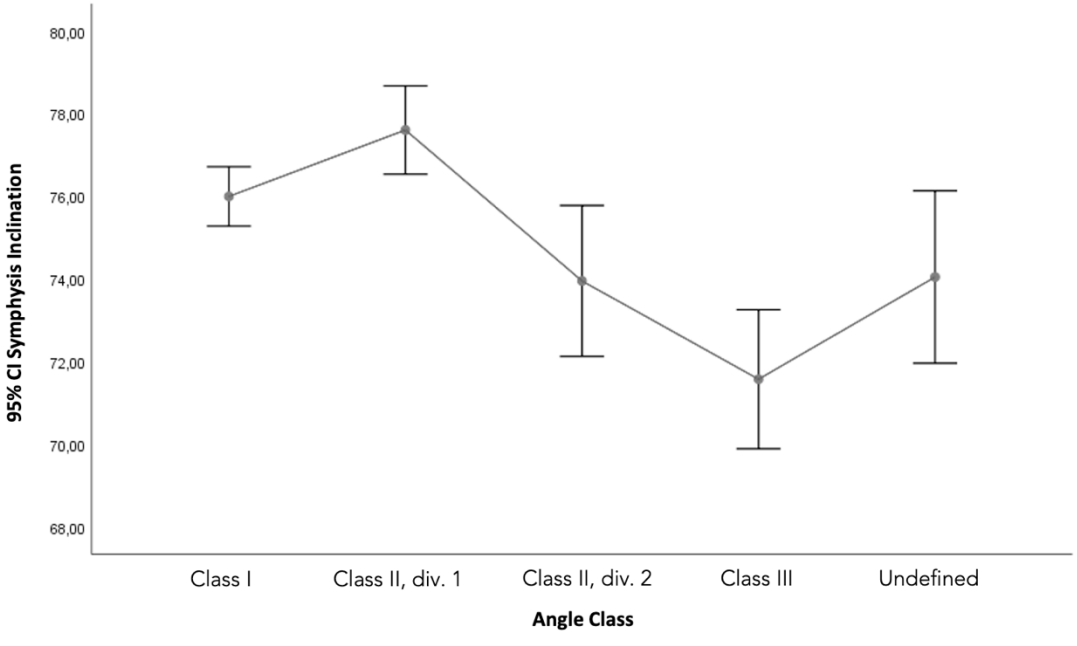


Figure 6. Mean values of symphysis inclination and respective 95% CI according to Angle's Class.

Table V presents the sample characterization data regarding the variables of the symphysis measurements, by sex (male and female) and in totality.

To assess whether there are differences in the mean measurements of male and female individuals, a t-student test was performed for the independent samples. The results of these tests are summarized in table VI.

According to these results, in terms of mean values, men have a significantly higher mean value than women in terms of symphysis thickness.

Table V. Summary measurements of the symphysis measurements.

		Male	Female	Total
MS height	Mean	32,22	31,43	31,65
	Median	32,74	31,49	31,73
	Standard Deviation	4,51	3,37	3,74
	Minimum	22,84	21,46	21,46
	Maximum	43,13	42,43	43,13
MS width	Mean	14,66	13,95	14,15
	Median	14,57	13,82	14,08
	Standard Deviation	2,08	1,81	1,92
	Minimum	8,82	9,68	8,82
	Maximum	23,36	23,56	23,56
MS inclination	Mean	76,42	75,63	75,85
	Median	76,63	75,69	76,00
	Standard Deviation	5,94	6,28	6,19
	Minimum	56,85	26,96	26,96
	Maximum	88,57	89,13	89,13

Table VI. Results of the t-student test for symphysis measurements according to sex.

	t	gl	p value	Result
MS height	1,871	203,358	0,063	Not significant
MS width	3,756	492	<0,0001	Significant
MS inclination	1,279	492	0,201	Not significant

Discussion

When analyzing the MS, its shape, dimension and inclination should be taken into account. Within the limits of variation, these are influenced by various factors, such as genetic factors, ethnicity, lower incisor inclination, and facial type [14-20].

The total sample consisted of 495 cases, with 71.1% females and 28.3% males. Regarding sexual dimorphism in the mandibular symphysis, men had a higher mean value for symphysis width than women (Table V), which is in agreement with the results obtained in other studies in which this parameter was analyzed [6,15,18,21-30]. In this research, men had an average width of 14.66 mm against 13.95 mm for females.

In the research by Yaser Khan et al. [11] the reported values were 13.00 mm for men and 11.81 mm for women, corroborating the existence of sexual dimorphism in terms of width. According to Formby [31], in general, females showed lesser growth changes than males, and the latter have more changes in the total depth of the skeleton in the pogonion area, thus justifying the higher values of symphysis thickness. Lesrel et al. [32] justify the differences in width in relation to gender by a compensatory bone phenomenon (remodeling) [25]. On the other hand, Iuliano-Burns [33] justifies the bone dimorphism in MS by the later growth in males and claims that the differences in bone width are partially established before puberty [34].

Regarding to height, although the difference was not statistically significant, there was also a difference among values, which was bigger in men than in women (Table V). In the present study, we obtained mean values of 32.22 mm for men and 31.43 mm for women. Compared with a study by Yaser Hamed Khan et al. [11] that evaluated the dimensions of the chin, and where the same method to analyze the height of the symphysis was used, the results they obtained were 28.95 mm for men and 28.31 mm for women. Both studies found a higher height symphysis in males compared to females.

Between the three dental classes, the height of the symphysis did not show significant differences, even though class III individuals were the ones with higher values. These results are in agreement with the results of other studies, which report that these individuals present greater vertical growth and that it is associated with an increase in cortical bone thickness [35,36].

Regarding the Angle Class, the height of the mandibular symphysis did not show significant differences between the three dental classes (Table IV, Figure 4). The symphysis width was significantly larger in Class II Div.2 individuals (Table IV, Figure 5). The inclination of the symphysis was significantly lower in individuals with dental Class III when compared to individuals with Class I. Individuals with Class II Div.1 had a bigger

inclination of the mandibular symphysis when compared to individuals with Class II Div.2 and Class III, although this difference is not statistically significant compared to Class I (Table IV, Figure 6).

The symphysis showed variations, which may be associated with a natural compensation for malocclusion, influencing the position of the teeth and their relationship with other dento-craniofacial structures [8,19,36-38].

It is currently agreed that the position of the mandibular incisors is directly related to the inclination of the MS, regardless of the type of occlusion [3,6,39]. Thus, the position of the mandibular incisors in relation to the supporting bone is an important factor in planning, in the evaluation of progress, as well as in determining the outcome of orthodontic treatment [40,41].

The shape of the symphysis is also associated with the amount of alveolar bone, with a narrow MS being associated with a thin alveolar bone and a wide MS with a thick alveolar bone [35,42]. A careful analysis of the bone condition of each individual should be performed before developing an orthodontic treatment plan, especially when considering a large amount of movement [14,15,43,44]. In patients with a thicker/wider symphysis, the protrusion of the incisors is aesthetically acceptable and, therefore, treatment without extractions is feasible [28,45]. On the other hand, a greater height of the symphysis and a small chin would be candidates for a treatment plan with extractions to compensate for discrepancies in the length of the dental arch [31]. The height and projection of the MS influence the adjacent soft tissue. It is also important to understand and consider the mandibular growth in the treatment plan to have more predictable results, thus determining the harmony and facial aesthetics [11,35,46,47].

The most appreciated structures for facial recognition and for the perception of empathy among others are contained within what has been defined as the "inner triangle" (a triangle whose base surrounds the eyebrows and one of the vertices is located in the chin) [1,2,47-49]. The chin is one of the most visible structures of the face, not only in frontal view, but also in profile view, and its prominence is one of the facial features that society tends to associate with an individual's personality. Thus, the treatment plan must take into account the morphology of the symphysis (height, width and inclination), the position of the lower incisors and the amount of bone available [28,29,35,36,50]. The treatment must consider both the hard tissues and the soft and the search for symmetry and proportionality of the face should prevail for a facial balance.

Conclusions

The width of mandibular symphysis had the highest values in Class II Division 2 individuals and the inclination had the lower values in Class III individuals.

The shape of mandibular symphysis is influenced by several factors and due to dental malocclusion, symphysis varies.

This highlights the importance of incorporating mandibular symphysis analysis when planning orthodontic treatment.

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