MORPHOLOGICAL CHARACTERISTICS OF MANDIBULAR SYMPHYSIS AND SAGITTAL INCLINATION OF LOWER INCISORS IN CLASS III MALOCCLUSION ACCORDING TO FACIAL DIVERGENCE PATTERN

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INTRODUCTION

Angle class III malocclusion is a dento-maxillary anomaly with a strong polymorphic character, with dental, alveolar and skeletal manifestations. Under this aspect, there are major aesthetic and functional consequences/implications that can significantly influence patients quality of life, thus increasing the addressability of these patients to the orthodontic practice. In order to establish an accurate and complete diagnosis, it is essential to closely investigate the relationship between the dentoalveolar and skeletal changes, and in this context the lateral cephalometric analysis is indispensable.

One of the most investigated cephalometric parameters is represented by the angle formed by the axis of the lower incisor and the mandibular plane (∡IMPA), this landmark being considered by Tweed the center of his treatment philosophy. Although the analysis of ∡IMPA is still a valuable diagnostic tool, subsequent research has emphasized both the limitations of this landmark and the importance of associating this angle with other cephalometric parameters, such as those characterizing mandibular symphysis morphology. (1) The mandibular symphysis is an important landmark for facial profile aesthetics, for predicting and evaluating the mandibular growth rotation and for determining the optimal position of the lower incisors.(2-5) Thus, the assessment of the inclination of the lower incisor in the sagital plane, its relationship with the alveolar process and the characteristics of the mandibular symphysis play an important role in orthodontic diagnosis, therapeutic planning and prognosis.

The aim of this study was to evaluate the morphology of the mandibular symphysis as well as the sagital inclination of the lower incisors in patients with class III malocclusion according to the facial divergence pattern.

MATHERIAL AND METHOD

Subjects

To carry out this cross-sectional descriptive study, we selected the medical records for a group of patients seeking orthodontic treatment at the Orthodontic and Dento-Facial Orthopedics Department of “Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania. The inclusion criteria for the research group was: dental class III malocclusion (based on study models) and skeletal class III relationship (based on pretreatment lateral cephalometric radiographs with angular parameter ∡ ANB < 0º), over the age of 14 (for female subjects) respectively 16 years (for male subjects). Cases with orthodontic treatment or previous craniofacial trauma, genetic syndromes, congenital malformations and incomplete or poor quality documentation were excluded from the study.

Informed patient consent was obtained for all selected cases, and the study research was was reviewed and approved by the Research Ethics Committee at the same institution and conducted in accordance with the Helsinki Declaration of 1975, revised in 2000.

Based on the established criteria, 52 subjects aged between 14 and 22 years were included in the research group, of which 57.7% were female and 42.3% were male.

In order to analyze the relationship between changes in the investigated cephalometric parameters and the facial divergence pattern, the subjects were divided into three groups according to the angle between the mandibular plane and the anterior part of the cranial base (∡SN-GoGn), whose average value for the Caucasian population was established by Schudy (6) at 32º. Thus, the sample was divided into three facial divergence groups, as follows: G1 patients with hypodivergence (∡SN-GoGn ≤ 29º), G2 patients with normal divergence (∡SN-GoGn 30-34º) and G3 patients with hyperdivergence (∡SN-GoGn ≥ 35º), the distribution being presented in figure 1.

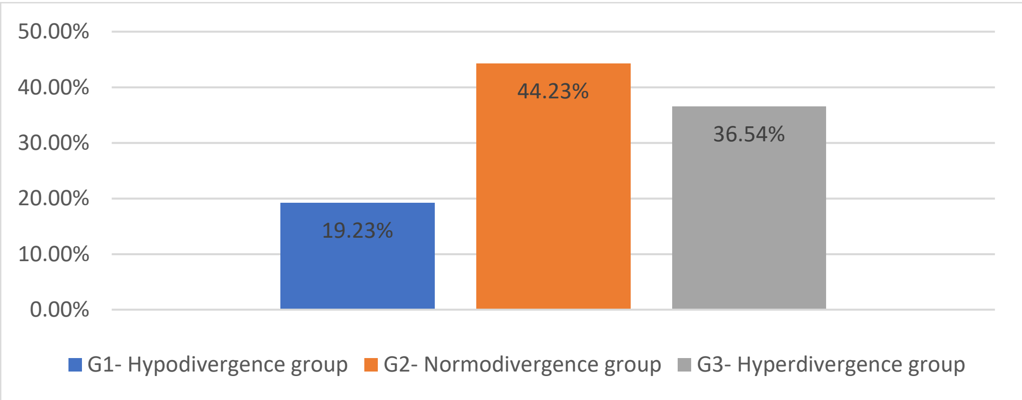

Figure 1. Distribution of subjects in the facial divergence groups according to ∡SN-GoGn: G1-19.23%, G2-44.23%, G3-36.54%

Cephalometric analysis

To increase reliability, all lateral cephalograms were made under standardized conditions and obtained from the same radiology center. Identification of anthropometric reference points (tab. I), tracing of cephalometric parameters and their measurements were performed by a single examiner.

Table I. Definition of mandibular symphysis anthropometric points traced on lateral cephalograms (7)

Anthropometric points (abbreviation)	***Description***
Infradentale (Id)	the highest, most anterior point on the alveolar process, in the median plane
Punctul B al lui Down (B)	the most posterior point on the outer contour of the mandibular alveolar process, in the median plane
Pogonion (Pog/Pg)	the most anterior point on the bony chin, in the median plane
Menton (Me)	midline and most caudal point in the outline of the symphysis, regarded as the lowest point of the mandible

For each lateral cephalogram 10 parameters were analyzed, of which 5 angular and 5 linear parameters (tab. II, fig. 2). In order to evaluate the study's measurement error resulting from the cephalometric analysis, twenty randomly selected lateral cephalograms were measured twice at least 1 month after the first interpretation. The values of the two measurements were compared for each parameter, using the paired Student's t-Test but no statistically significant differences were detected between the measurements ($p > 0.05$).

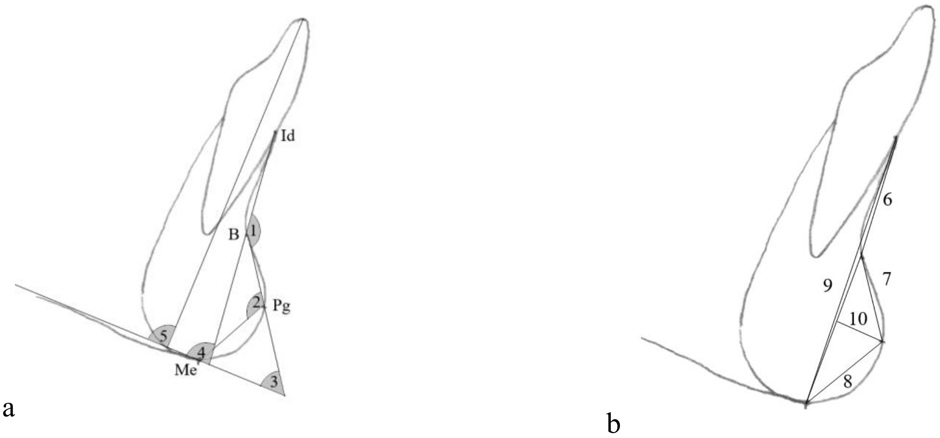

Figure 2. Schematic representation of the analyzed cephalometric parameters
a. Angular parameters (º): 1 ∡ Id-B-Pg; 2 ∡ B-Pg-Me; 3 ∡BPg-GoMe; 4 ∡ IdB-GoMe; 5 ∡ IMPA;
b. Linear parameters (mm): 6 distance Id-B; 7 distance B-Pg; 8 distance Pg-Me; 9 distance Id-Me; 10 distance Pg – BMe.

Table II. Cephalometric parameters evaluated in the study

Abbreviation of cephalometric parameters	***Description***
Angular cephalometric parameters	
∡ Id-B-Pg (º)	Angle between Id, point B and Pg, which reflects the concavity of mandibular symphysis (8)
∡ B-Pg-Me (º)	Angle between point B, Pg and Me, which reflects the convexity of mandibular symphysis (8)

∡BPg-GoMe (º)	Angle between a line connecting point B to Pg and the mandibular plane, which reflects the sagittal inclination of the skeletal part of the mandibular symphysis in relation to the mandibular plane (8)
∡ IdB-GoMe (º)	Angle between a line connecting Id to point B and the mandibular plane, which reflects the sagittal inclination of the alveolar part of the mandibular symphysis in relation to the mandibular plane (8)
∡ IMPA (º)	Angle between the long axis of lower incisor and mandibular plane, which reflects the sagittal inclination of the mandibular incisors in relation to the mandibular plane
Linear cephalometric parameters	
Id-B (mm)	Linear distance between Id and point B, which reflects the height of the alveolar part of the mandibular symphysis (8)
B-Pg (mm)	Linear distance between point B and Pg, which reflects the height of the skeletal part of the mandibular symphysis (8)
Pg-Me (mm)	Linear distance between Pg and Me, which reflects the chin length (5)
Id-Me (mm)	Linear distance between Id and Me, which reflects the total height of mandibular symphysis (8)
Pg - BMe (mm)	Perpendicular distance from Pg to the line connecting point B and Me, which reflects the anterior prominence of the mandibular symphysis (8)

Statistical analysis

Using Microsoft Office Excel (2019), we centralized the parameter values and analyzed their characteristics by means of descriptive statistics. The Shapiro-Wilk test revealed a normal distribution of the values, which allowed the use of the parametric Student's t-Test for the comparative analysis of the results and the linear correlation coefficient r of Pearson to evaluate the degree of association between the variables. The level of statistical significance (p) was set at a maximum of 0.05.

RESULTS

Results of the study highlighted the variation of all investigated cephalometric parameters depending on the facial divergence, but statistically significant differences were identified only for 5 parameters, namely: ∡ Id-B-Pg, ∡ IdB-GoMe (º), ∡ IMPA (º), Id-B distance (mm) and B-Pg distance (mm) (tab. III).

Table III. Mean values (mean) and standard deviations (SD) for investigated cephalometric parameters, grouped according to facial divergence; the difference between the mean values recorded for each group separately and the values of the statistical significance coefficient (p) for the student t-test.

Cephalometric parameter	G1		G2		G3		Difference between G1 and G2	Difference between G1 and G3	Difference between G2 and G3
	Mean	SD	Mean	SD	Mean	SD			
∡ Id-B-Pg (º)	149.75	1.75	158.75	6.25	159.67	4.11	-9 **(p=0.023)**	-9.92 **(p=0.011)**	-0.92 (s.i.)
∡ B-Pg-Me (º)	122.25	2.88	124.25	5.25	127.17	4.83	2.92 (s.i.)	4.92 (s.i.)	-2.92 (s.i.)
∡BPg-GoMe (º)	63.5	2	60.31	5.02	58.17	7.44	3.19 (s.i.)	5.33 (s.i.)	2.14 (s.i.)
∡ IdB-GoMe (º)	87.5	2.5	80.25	8.06	78.58	7.42	7.25 **(p=0.043)**	8.92 **(p=0.011)**	1.67 (s.i.)
∡ IMPA (º)	91.4	9.3	83.58	8.72	80.33	3.67	7.82 (s.i.)	11.07 **(p=0.011)**	3.25 (s.i.)

Id-B (mm)	7.93	1.4	7.78	1.71	9.88	0.74	0.15 (s.i.)	-1.95 **(p=0.017)**	-2.1 **(p=0.027)**
B-Pg (mm)	11.93	1.93	14.01	3.44	14.52	1.95	-2.08 (s.i.)	-2.59 **(p=0.029)**	-0.51 (s.i.)
Pg-Me (mm)	8.6	1.3	9.01	1.79	8.08	2.25	-0.41 (s.i.)	0.52 (s.i.)	0.93 (s.i.)
Id-Me (mm)	26.75	3.25	28.2	4.55	28.97	2.17	-1.45 (s.i.)	-2.22 (s.i.)	-0.77 (s.i.)
Pg-BMe (mm)	4.53	1.03	5.3	1.53	4.85	0.9	-0.77 (s.i.)	-0.32 (s.i.)	0.45 (s.i.)

p - statistical significance for Student's t-Test; s.i. - statistically insignificant

Thus, ∡Id-B-Pg(°) was significantly higher for class III malocclusion subjects with hyperdivergent facial pattern compared to those with hypodivergent facial pattern, the average difference being 9.92°. However, the results for the ∡Id-B-Pg parameter in case of subjects with normodivergent pattern were similar to those with a hyperdivergent pattern.

For ∡IdB-GoMe(°) results indicated lower values for subjects with hyperdivergence. The differences were significant between subjects with hyperdivergent and hypodivergent patterns (8.92°), but also between those with hyperdivergent and normodivergent patterns (7.25°).

Similar to the previous parameter, measurements for ∡ IMPA (°) also varied, the lowest values being recorded for subjects with hyperdivergent facial pattern, with statistically significant differences between this group and the hypodivergent facial pattern group (11.07°).

Regarding the linear cephalometric parameters, only Id-B (mm) and B-Pg (mm) distances showed statistically significant variations between groups (tab. III).

Measurements for Id-B(mm) parameter were significantly higher in subjects with hyperdivergent facial pattern, but without significant differences for subjects with normo- and hypodivergent facial pattern. Additionally, for B-Pg (mm) parameter, the values were significantly larger for subjects with hyperdivergent facial pattern compared to those with hypodivergent pattern, but similar to those obtained for normodivergent subjects.

Considering the other analyzed cephalometric parameters, no statistically significant differences were noted. However, for subjects with a hyperdivergent facial pattern, the values recorded for the parameters ∡B-Pg-Me(°) and Id-Me (mm) were higher.

The Pearson correlation coefficient expressed the degree of association between all investigated parameters for subjects with class III malocclusion within this study (tab. IV).

Table IV. Results for Pearson's linear correlation coefficient (r).

Cephalometric parameter	∡ Id-B-Pg (°)	∡ B-Pg-Me (°)	∡BPg-GoMe (°)	∡ IdB-GoMe (°)	∡ IMPA (°)	Id-B mm	B-Pg mm	Pg-Me mm	Id-Me mm	Pg-BMe mm
∡ Id-B-Pg (°)	1	0.186	0.423	-0.13	-0.046	-0.379	-0.233	-0.356	-0.437	-0.441
∡ B-Pg-Me (°)	0.186	1	0.403	-0.166	-0.070	0.387	0.223	-0.039	0.223	0.127
∡BPg-GoMe (°)	0.423	0.403	1	0.398	0.433	-0.219	-0.247	-0.416	-0.452	-0.375
∡ IdB-GoMe (°)	-0.13	-0.166	0.398	1	0.653*	-0.143	-0.415	-0.202	-0.423	-0.270

∡ IMPA (º)	-0.046	-0.070	0.433	0.653*	1	-0.376	-0.303	-0.094	-0.406	-0.140
Id-B mm	-0.379	0.387	-0.219	-0.143	-0.376	1	0.342	0.275	0.665*	0.577*
B-Pg mm	-0.233	0.223	-0.247	-0.415	-0.303	0.342	1	0.139	0.744**	0.567*
Pg-Me mm	-0.356	-0.039	-0.416	-0.202	-0.094	0.275	0.139	1	0.611*	0.683*
Id-Me mm	-0.437	0.223	-0.452	-0.423	-0.406	0.665*	0.744**	0.611*	1	0.801**
Pg-BMe mm	-0.441	0.127	-0.375	-0.270	-0.140	0.577*	0.567*	0.683*	0.801**	1

r ϵ [0; 0.19] - very weak correlation, r ϵ [0.2; 0.29] - weak correlation, r ϵ [0.3; 0.49] - average correlation, *r ϵ [0.5; 0.69] - strong correlation, **r ϵ [0.7; 0.89] - very strong correlation, r ϵ [0.9; 1] - perfect correlation

In this regard, a very strong positive linear association was noted between the parameters Id-Me (mm) and B-Pg (mm) (r=0.744) and Pg-BMe (mm) (r=0.801). Also, a strong positive linear correlation was revealed between ∡ IdB-GoMe (º) and ∡ IMPA (º) (r=0.653), between Id-Me (mm) and Id-B mm (r=0.665) respectively Pg-Me mm (r=0.611) and between Pg-BMe mm and Id-B (mm) (r=0.577), B-Pg (mm) (r=0.567) and Pg-Me (mm) (r=0.683).

DISCUSSIONS

Our results revealed that the morphology of mandibular symphysis and the axis of the lower incisors differ for patients with class III malocclusion according to the facial divergence, pattern, differences between the three groups even being statistically significant for three angular and two linear parameters.

The concavity angle of the mandibular symphysis was significantly greater in subjects with hyperdivergent facial pattern compared to those with hypodivergent facial pattern, but similar for subjects with normodivergent pattern. Looking at the results as a whole, the variation of this parameter is related to the changes found in the inclination of the alveolar and skeletal portion of the mandibular symphysis, in case of the latter parameter (∡BPg-GoMe) an average positive linear correlation was even identified.

Both the alveolar segment of the mandibular symphysis and the lower incisor axis showed an increase in lingual inclination towards the mandibular plane as the facial divergence angle grew. Thus, the values recorded in case of both cephalometric parameters (∡ IdB-GoMe and ∡IMPA) were lower for hyperdivergent subjects. The results of our study are consistent with other studies, which show that, for class III malocclusion patients with skeletal discrepancies, a phenomenon of dento-alveolar compensation is associated. (9) In other words, the axis of the lower incisors and the related alveolar process varies with the facial pattern both sagittally and vertically.

In our study, the variation of the results for the two aforementioned parameters (∡ IdB-GoMe and ∡IMPA) was similar, which suggests that, in case of severe skeletal discrepancy, the compensatory lingual inclination of the lower incisors is associated with the lingual inclination of the alveolar process, thus maintaining a optimal position of the lower incisors in the bone, favorable to periodontal health.

Further research carried out on two/threedimensional radiological investigations showed that for class III malocclusions, the alveolar bone associated with lower incisors is more lingually inclined and thinner than that found in normal occlusions. (10-12) These authors claim that more attention should be paid during orthodontic treatment towards maintaining the lower incisor in the alveolar bone than to the axis of the lower incisor relative to the mandibular plane because dental alignment based only on ∡IMPA parameter can cause a repositioning of the incisors outside the biological limits of the alveolar process, leading to severe periodontal issues. (13)

Regarding mandibular symphysis dimensions, only the Id-B(mm) parameter varied significantly between subjects with hyperdivergent facial pattern and the other two groups. This parameter seems to suggest that the adaptation to the vertical facial pattern occurs mainly at the level of the alveolar portion of the mandibular symphysis.

The results of our study are also supported by other studies, such as those carried out by Chung et. Al. (2008), Al-Khateeb et al. Al. (2014) and Swasty et al. Al. (2011) who stated that as the height of the lower facial third increases, the maxillary and mandibular anterior teeth may continue to erupt in an attempt to maintain a favorable vertical occlusal relationship, bringing the alveolar bone support with them, thus resulting in an increase in the height of the alveolar process, and consequently the mandibular symphysis height.(8,14,15) Also in our study the total height of the mandibular symphysis (Id-Me) increased proportionaly to the degree of facial divergence, but the differences between the three groups were not statistically significant.

The convexity of the mandibular symphysis was evaluated by an angular parameter ∡ B-Pg-Me (convexity angle of the mandibular symphysis) and a linear one Pg-BMe (perpendicular distance from Pg to the B-Me line). Although the statistical analysis did not reveal significant differences between the recorded values according to ∡SN-GoGn, the Pearson correlation indicated a very strong positive linear association between the anterior prominence and the total height of the mandibular symphysis (r=0.801).

Other studies have also investigated the variation of these parameters. (4-5) In this regard, the study by Gomez et al. (2018), reported significant interactions between the vertical dimension of the mandibular symphysis and its convexity. (4) In our study, the mandibular symphysis convexity angle showed only a moderate correlation with the height of the alveolar segment of the mandibular symphysis. In Contrast to our research, in other studies, the convexity angle of the mandibular symphysis (∡ B-Pg-Me) varied significantly with the skeletal facial pattern. (16)

Some recent studies (5, 17) have emphasized the relationship between the morphology of the mandibular symphysis and the vertical skeletal pattern, especially in case of patients with an increased facial height. Other studies revealed that the thickness of the mandibular symphysis was greater in subjects with a short face compared to those with a long face and showed that individuals with a short lower facial height had better periodontal support of the mandibular incisors compared to individuals with a high lower facial third. (3, 12,15 18,19,20).

However, the results of our study must be analyzed taking into account the limitations associated with small sample size, which makes it difficult to outline an overall picture of the changes that appear for patients with class III malocclusions. Also, two-dimensional investigations such as lateral cephalograms limit the research to linear and angular measurements established between superimposed landmarks on a single reference plane, which can induce errors due to deformations.

CONCLUSIONS

The morphology of the mandibular symphysis and the sagittal inclination of the lower incisors in patients with class III malocclusion varies also according to the pattern of facial divergence. For this study:

The concavity angle of the mandibular symphysis was significantly higher for class III patients with a hyperdivergent facial pattern compared to those with a hypodivergent facial pattern.

Sagittal inclination of the alveolar part of the mandibular symphysis and that of lower incisors relative to the mandibular plane decreases as the angle of facial divergence increases. Thus, the values recorded in case of both cephalometric parameters (∡ IdB-GoMe and ∡ IMPA) were lower for hyperdivergent pattern.

Regarding the dimensions of mandibular symphysis, Id-B(mm) varied significantly among the three patterns of facial divergence. This result suggests that the adaptation to vertical facial pattern occurs mainly in the alveolar portion of the mandibular symphysis. The skeletal portion of the mandibular symphysis was similar for subjects with hyper- and normodivergent facial pattern, but significantly greater than for those with hypodivergent facial pattern. The total height of the mandibular symphysis did not vary significantly between the three groups, but analyzing the pattern of variation, a slight increase in height is observed as the facial divergence becomes greater. Neither did anterior prominence of mandibular symphysis vary significantly according to the pattern of facial divergence, which emphasizes the variety of factors influencing bone remodeling at this level. However, a strong positive linear correlation was noted between the anterior prominence and the height of the mandibular symphysis.

Thus, the findings of the current study support the importance of evaluating the mandibular symphysis morphology along with the sagittal inclination of the lower incisors for diagnosis and orthodontic treatment planning.

REFERENCES

1. Jieni Zhang, Yuqi Liang, Rui Chen, Si Chen et. al, Inclination of mandibular incisors and symphysis in severe skeletal class III malocclusion, Head & Face Medicine, 2023, 19:16
2. Bjork A. Prediction of mandibular growth rotation. Am J Orthod., 1969; 55:585–599.
3. Molina-Berlanga N, Llopis-Perez J, Flores-Mir C, Puigdollers A., Lower incisor dentoalveolar compensation and symphysis dimensions among Class I and III malocclusion patients with different facial vertical skeletal patterns. Angle Orthod, 2013, 83(6):948-955.
4. Gómez, Y., García-Sanz, V., Zamora, N., Tarazona, B. et al., Associations between mandibular symphysis form and craniofacial structures. Oral Radiol, 2018., 34 (2), 161–171.
5. A.I. Linjawi, A.R. Afify, H.A. Baeshen et al., Mandibular symphysis dimensions in different sagittal and vertical skeletal relationships, Saudi Journal of Biological Sciences, 2020, https://doi.org/10.1016/j.sjbs.2020.09.062
6. Schudy FF., Vertical growth versus anteroposterior growth as related to function and treatment., Angle Orthodontist 1964; 34:75-93.

7. Rakosi, T., An Atlas and Manual of Cephalometric Radiography. Munich: Wolfe Medical Publications;1982.
8. Al-Khateeb SN, Al Maaitah EF, Abu Alhaija ES, Badran SA. Mandibular symphysis morphology and dimensions in different anteroposterior jaw relationships. Angle Orthod. 2014;84(2):304-309. doi: 10.2319/030513-185.1. Epub 2013 Aug 5. PMID: 23914822; PMCID: PMC867381
9. Kim SJ, Kim KH, Yu HS, Baik HS. Dentoalveolar compensation according to skeletal discrepancy and overjet in skeletal Class III patients. Am J Orthod Dentofacial Orthop. 2014 Mar;145(3):317-24. doi: 10.1016/j.ajodo.2013.11.014. PMID: 24582023.
10. Yamada C, Kitai N, Kakimoto N, Murakami S et al, Spatial relationships between the mandibular central incisor and associated alveolar bone in adults with mandibular prognathism. Angle Orthod. 2007;77(5):766–72. https:// doi. org/ 10. 2319/ 072906- 309.
11. Kim Y, Park JU, Kook YA. Alveolar bone loss around incisors in surgical skeletal Class III patients. Angle Orthod. 2009;79(4):676–82. https:// doi.org/ 10. 2319/ 070308- 341.1.
12. Ma H, Li W, Xu L, Hou J, Wang X, Ding S, Lv H, Li X. Morphometric evaluation of the alveolar bone around central incisors during surgical orthodontic treatment of high-angle skeletal class III malocclusion. Orthod- Craniofac Res. 2021;24(1):87–95. https:// doi. org/ 10. 1111/ ocr. 12408.
13. Chen Si, Lyv Wenxuan, Zhang Yunfan, Huang Wenbin et al, Study of the relationship between the long axis of the mandibular symphysis and the lower incisors in natural dentition based on cephalometric analysis, Chinese Journal of Orthodontics, 2020; 4: 191-196.
14. Chung C.J., Jung S., Baik H.S. Morphological characteristics of the symphyseal region in adult skeletal Class III crossbite and openbite malocclusions. Angle Orthod., 2008; 78(1):38-43.
15. Swasty D, Lee J, Huang JC, et al. Cross-sectional human mandibular morphology as assessed in vivo by cone-beam computed tomography in patients with different vertical facial dimensions. Am J Orthod Dentofacial Orthop., 2011; 139:e377–e389.
16. Mohamad Mahfoud, Hazem Hassan, Symphysis morphology and dimensions in different vertical facial patterns (CBCT scan study), Revista Românå De Stomatologie, 2015, LXI(3):217-226.
17. Ahn, M.S., Shin, S.M., Yamaguchi, T., Maki, K., Wu, T.-J., Ko, C.-C., Kim, Y.-I., Relationship between the maxillofacial skeletal pattern and the morphology of he mandibular symphysis: Structural equation modeling. Korean J Orthod, 2019, 49 (3), 170. https://doi.org/10.4041/kjod.2019.49.3.170.
18. Gracco, A., Luca, L., Bongiorno, M.C., Siciliani, G., Computed tomography evaluation of mandibular incisor bony support in untreated patients. American Journal of Orthodontics and Dentofacial Orthopedics, 2010, 138 (2), 179–187.
19. Sadek MM, Sabet NE, Hassan IT., Alveolar bone mapping in subjects with different vertical facial dimensions. Eur J Orthod, 2015, 37(2):194-201
20. Foosiri, P., Mahatumarat, K., Panmekiate, S., Relationship between mandibular symphysis dimensions and mandibular anterior alveolar bone thickness as assessed with cone-beam computed tomography. Dental Press J. Orthod., 2018, 23 (1), 54–62. https://doi.org/10.1590/2177-6709.23.1.054-062.oar.