ORIGINAL STUDIES
ORIGINALNI NAUČNI RADOVI

University of Novi Sad, Faculty of Medicine Novi Sad
Dental Clinic of Vojvodina, Novi Sad

Original study
Originalni naučni rad
UDK 616.314.21/.22-007.26
https://doi.org/10.2298/MPNS2210279P

DETERMINATION OF DENTOALVEOLAR PARAMETERS IN PATIENTS WITH PROGENIA

UTVRĐIVANJE DENTOALVEOLARNIH PARAMETARA KOD PACIJENATA SA PROGENIM ZAGRIŽAJEM

Nataša PUŠKAR, Milica PUŠKAR, Predrag VUČINIĆ, Stojan IVIĆ and Đorđe PETROVIĆ

Summary

Introduction. Class III malocclusions are characterized by a more prominent lower jaw compared to the upper jaw and a Class III skeletal and dentoalveolar relationship according to Angle. In the scientific literature, there is a small amount of data on the morphological characteristics of malocclusion in different populations, so there is a justified need to examine the morphological characteristics of Class III malocclusion in the population of Vojvodina. The aim of this study was to determine the morphological characteristics of Class III malocclusions, to compare them with the average values found in the scientific literature, and to determine the correlation between the examined parameters of the upper and lower jaw. **Material and Methods.** This retrospective study included subjects with Class III dentoalveolar malocclusion treated at the Dentistry Clinic of Vojvodina in Novi Sad. The method of random selection was used to select 50 study models. The data were statistically processed with a significance level of $p < 0.05$. **Results.** The obtained results indicate that the sum of crown width of the mandibular incisors, the length of the mandibular dental arch, and the mandibular apical base in subjects with Class III malocclusion are higher than the average values in the general population. The values of the posterior width of the maxillary dental arch in the examined group are lower compared to the average values in the general population. **Conclusion.** Subjects with Class III malocclusion present with a greater mandibular dental arch in regard to the maxillary dental arch.

Key words: Malocclusion; Prognathism; Malocclusion, Angle Class III; Cephalometry; Incisor; Dental Arch

Sažetak

Uvod. Malokluzije III klase karakteriše razvijenija donja vilica u odnosu na gornju i skeletni i dentoalveolarni odnos III klase po Englu. U naučnoj literaturi postoji mali broj podataka o morfološkim karakteristikama malokluzija u različitim populacijama, pa zato postoji opravdana potreba za ispitivanjem morfoloških karakteristika kod malokluzije III klase u vojvođanskoj populaciji. Cilj rada bio je da se utvrde morfološke karakteristrike malokluzija III klase; da se one uporede sa prosečnim vrednostima u populaciji koje su dobijene iz naučne literature i da se utvrdi korelacija između ispitivanih parametara u gornjoj i donjoj vilici. **Materijal i metode.** Istraživanje je sprovedeno kao retrospektivna studija na studijskim modelima ispitanika koji imaju dentoalveolarnu malokluziju III klase, a koji su lečeni na Klinici za stomatologiju Vojvodine u Novom Sadu. Metodom slučajnog izbora odabrano je 50 studijskih modela. Podaci su statistički obrađeni sa nivoom značajnosti $p < 0,05$. **Rezultati.** Dobijeni rezultati ukazuju na to da je suma širine krunica donjih inciziva, dužina mandibularnog zubnog luka i mandibularne apikalne baze kod ispitanika sa malokluzijom III klase veća od prosečnih vrednosti u populaciji. Vrednosti zadnje širine gornjeg zubnog luka u ispitivanoj grupi su manje u odnosu na prosečne vrednosti u populaciji. **Zaključak.** Ispitanici sa malokluzijom III klase imaju veću razvijenost donjeg, a manju razvijenost gornjeg zubnog luka.

Ključne reči: malokluzija; progenija; malokluzija III klase po Englu; cefalometrija; incizor; zubni luk

Introduction

The main characteristic of true prognathism is mandibular protrusion compared to the maxilla in the sagittal and transverse planes. Skeletal and dentoalveolar relationships are Class III according to Angle, which is most often the consequence of prognathism of the mandible, combined with changes in the teeth, alveolar processes, jaws and the cranial base [1].

In addition to true prognathism, there is also pseudo-prognathism, where the maxilla is underdeveloped compared to average values, as well as forced prognathism, which is functional in nature and occurs due to premature contact between anterior teeth [1]. Mandibular prognathism may seriously compromise some of the basic functions: breathing, chewing, swallowing and speaking. Considering that it is one of the most severe facial disharmonies, Class III malocclusion is

Corresponding Author: Prof. dr Predrag Vučinić, Univerzitet u Novom Sadu, Medicinski fakultet Novi Sad, Klinika za stomatologiju Vojvodine, 21000 Novi Sad, Hajduk Veljkova 12, E-mail: predrag.vucinic@mf.uns.ac.rs

often accompanied by psychological and social problems [1].

According to Angle's classification, when the skeletal and occlusal relationships are Class III, the mandible and the mandibular dental arch are located mesially in relation to Class I, and the mesiobuccal cusp of the upper first molar is in occlusion with the mesial part of the lower second molar, and the tip of the cusp of the upper canine with both lower premolars. Inverted incisor overlap is usually present as well (in physiological rest position, the lower incisors are positioned in front of the upper ones) [2].

In orthodontic diagnostics, gnathometric analysis is a valuable tool, based on which one can obtain data on the position of the teeth, the shape and development of the dental arches and jaws, and occlusal relationships [1, 3].

The research was aimed to determine the morphological characteristics of persons with Class III malocclusion and dentoalveolar relations according to Angle, to compare the measured and average values, as well as to determine the correlation between the same parameters in the upper and lower jaw.

Material and Methods

The study was conducted at the Dental Clinic of Vojvodina, Department of Jaw Orthopedics, during November and December 2022. This retrospective study included 50 study models obtained from patients of both sexes, aged 8 - 14, who were treated at the Dental Clinic of Vojvodina, chosen by using the method of random selection. The inclusion criteria were existence of a full dental arch and Class III dentoalveolar relationships according to Angle.

Gnathometric analysis included the following parameters in both jaws:

1. Sum of incisors - total incisor width measured in the mesiodistal direction;
2. Anterior width of the dental arch - interpremolar distance;
3. Dental arch height - distance from the labial surface of the incisors to the anterior width of the arch;
4. Posterior width of the dental arch - intermolar distance;
5. Dental arch length - distance from the right first permanent molar to the left one measured along the occlusal surfaces;
6. Length of the apical base - distance from the right first permanent molar to the left one measured along the fornix.

We measured the maxillomandibular relationship, as well as the relationships of the length of the maxillary and mandibular dental arches, based on the length of the apical base and the length of the dental arch.

Gnathometric analysis was performed on plaster cast models. To measure the anterior and posterior width, and the height of the arch, Korkhaus three-dimensional calliper was used. To determine the sum of incisors, an ortho-compass with straight arms and a millimetre scale was used. A self-adhesive tape and a ruler were used to measure the length of the apical base, while a copper wire was used to measure the length of the dental arch. Average values were taken from the tables for dental arch analysis according to Schwarz and the table of ideal ratios of the coronary and apical bases lengths according to Rees [3].

The evaluation of the results was carried out by comparing the measured values with the corresponding average values from the tables according to Schwartz and Rees.

The statistical analysis of the results included determination of the mean value, standard deviation, minimum, maximum value, Pearson correlation test and t-test with a significance level of $p < 0.05$. The results are presented tabularly.

Results

The research results show that in Class III malocclusions, there is a greater development of the lower and lesser development of the upper dental arch.

Table 1 shows descriptive statistics for all the parameters measured: their mean values, standard deviation, as well as minimum and maximum measured values.

The mean value of the measured sum of maxillary incisors is 31.85 mm, which is a slightly higher than the average of 31.50 mm; however, the difference is not statistically significant. The mean value of the measured sum of mandibular incisors is 22.97 mm, which is statistically significantly higher than the average value from the tables of mean values (21.75), $p < 0.05$.

The mean height of the maxillary arch is slightly higher than the average value in the population (19.15 mm). It is 20.15 mm, but the difference is not statistically significant, $p = 0.202$.

The mean value of the height of the mandibular arch is 17.63 mm, which is in the range of the average values in the population (17.50 mm), $p = 0.728$.

The mean anterior maxillary arch width is 37.29 mm, while the mean anterior mandibular arch width is 37.38 mm. In the upper and lower jaw, the anterior width of the dental arch is smaller than the average values in the population, for the same sum of incisors, $p < 0.05$.

The posterior width of the dental arch is smaller in both the upper and lower jaw compared to the average posterior width of the arch (49 mm) for the same number of incisors. The mean posterior width of the upper dental arch is 46.45 mm, while the mean intermolar distance of the lower dental arch is 48.79 mm. The difference is statistically significant for the upper ($p < 0.05$), but not for the lower dental arch. The comparison between the obtained results and the average values in the population is shown in **Table 2**.

The relationship between the measured dimensions of the maxillary apical base and the maxillary dental arch is statistically lower than the values according to Rees and it is 1.1 mm ($p < 0.05$).

The relationship between the mandibular apical base and the mandibular dental arch is 7.25 mm, which is statistically significantly higher than the ideal values according to Rees ($p < 0.05$).

The measured relationship between the maxillary and mandibular apical base is 3.52 mm, which is not statistically significantly different from the recommended Rees values (p = 0.09).

Table 1. Descriptive statistics of measured parameters in millimeters
Tabela 1. *Deskriptivna statistika izmereneih parametara u milimetrima*

	Mean value *Srednja vrednost*	Standard deviation *Standardna devijacija*	Minimum measured value *Minimalna izmerena vrednost*	Maximum measured value *Maksimalna izmerena vrednost*
Sum of maxillary incisors/*Suma gornjih inciziva*	31.85	2.41	29.00	36.00
Sum of mandibular incisors/*Suma donjih inciziva*	22.97	1.63	19.00	27.00
Maxillary arch height/*Visina gornjeg luka*	20.15	2.80	15.50	27.00
Mandibular arch height/*Visina donjeg luka*	17.63	2.24	14.00	24.00
Maxillary anterior teeth width/*Prednja širina gornje vilice*	37.29	3.65	30.50	45.50
Mandibular anterior teeth width/*Prednja širina donje vilice*	37.38	2.44	32.00	42.00
Maxillary posterior teeth width/*Zadnja širina gornje vilice*	46.45	3.25	36.50	52.00
Mandibular posterior width/*Zadnja širina donje vilice*	48.83	2.80	46.00	56.00
Maxillary apical base length to dental arch ratio *Odnos dužine apikalne baze i zubnog luka u gornjoj vilici*	+1.10	4.60	-7.00	+8.00
Mandibular apical base length to dental arch ratio *Odnos dužine apikalne baze i zubnog luka u donjoj vilici*	+7.25	2.53	-1.00	+11.00
Correlation between maxillary and mandibular apical base lengths/*Odnos dužine apikalnih baza gornje i donje vilice*	+3.52	5.28	-9.00	+16.00
Correlation between maxillary and mandibular dental arch lengths/*Odnos dužine zubnih lukova gornje i donje vilice*	+9.51	7.52	-5.00	+30.00

Table 2. Correlation between the measured and average maxillary and mandibular parameters in millimeters
Tabela 2. *Odnos izmerenih i prosečnih, tabelarnih vrednosti parametara u gornjoj i donjoj vilici u milimetrima*

	Measured value *Izmerena vrednost*	Average value *Prosečna vrednost*	Statistical significance *Statistička značajnost*
Maxillary sum of incisors/*Suma inciziva gornje vilice*	31.85	31.50	p=0.58
Mandibular sum of incisors/*Suma inciziva donje vilice*	22.97	21.75	p<0.05
Maxillary arch height/*Visina luka gornje vilice*	20.15	19.50	p=0.20
Mandibular arch height/*Visina luka donje vilice*	17.63	17.50	p=0.72
Maxillary anterior width/*Prednja širina gornje vilice*	37.29	39.00	p<0.05
Mandibular anterior width/*Prednja širina donje vilice*	37.38	39.00	p<0.05
Maxillary posterior width/*Zadnja širina gornje vilice*	46.45	49.00	p<0.05
Mandibular posterior width/*Zadnja širina donje vilice*	48.79	49.00	p=0.72

Table 3. Measured values of the apical base and dental arch parameters in regard to the recommended values according to Rees in millimeters
Tabela 3. *Prikaz izmerenih vrednosti apikalnih baza i dentalnih lukova u odnosu na preporučene vrednosti po Risu u milimetrima*

Measurement *Merenje*	Measured values *Izmerena vrednost*	Ideal values acc. to Rees *Idealne vrednosti po Risu*	Statistical significance *Statistička značajnost*
Correlation between the maxillary apical base length and dental arch length *Odnos dužine maksilarne apikalne baze i zubnog luka*	+1.10	+1.5 to +5.0	p < 0.05
Correlation between the mandibular apical base length and dental arch length/*Odnos dužine mandibularne apikalne baze i zubnog luka*	+7.25	+1.5 to +7.0	p < 0.05
Correlation between the maxillary and mandibular apical base length *Odnos dužine maksilarne i mandibularne apikalne baze*	+3.52	+3.0 to 9,5	p = 0.09
Correlation between the maxillary and mandibular dental arch length *Odnos dužine maksilarnog i mandibularnog zubnog luka*	+9.51	+5.0 to +10.0	p = 0.175

The relationship between the maxillary and mandibular teeth is within the recommended values, given the fact that it is 9.51 mm **(Table 3)**.

The examination of the relations and interdependence of the corresponding parameters in the upper and lower jaw, no statistically significant correlation was found.

The correlation between the sum of maxillary and mandibular incisors is positive, but not statistically significantly high, r = + 0.49.

The correlation between the height of the maxillary arch and the height of the mandibular arch is positive, but not statistically significantly high, r = + 0.36.

The correlation between the height of the maxillary and mandibular arches is positive, but very low r = + 0.20.

The correlation between the posterior width of the maxillary and mandibular arches is positive, but has no statistical significance, r = + 0.32.

The correlation between the length of the apical bases of the maxilla and mandible is positive, but not statistically significantly high, r = + 0.38.

The correlation between the length of the dental arches of the maxillary and mandibular is positive, but very low, r = + 0.048.

Discussion

Gnathometric analysis of the study models, whether they are cast or digital, is an indispensable diagnostic method by which, without exposing the patient to X-ray radiation, data are obtained to establish the diagnosis and determine the treatment plan. As a research method, it is present in contemporary research on the morphological characteristics of malocclusions in different populations [2, 4–8].

The etiology of Class III malocclusions is a current and insufficiently researched issue [9]. The major cause of malocclusion is the disproportion between the size of the jaws and the teeth on the one hand, and the disproportion between the size of the upper and lower jaw on the other [1]. As a consequence of the disproportion between the jaws, in the case of prognathism of the lower jaw, a bilateral crossbite or an open bite may occur. In the lower dental arch, a coronal crowding in the front may appear due to retroclined incisors, with or without compensatory proclination of the upper incisors [10–12]. These factors are determined by the ratio of the apical base length to the coronally measured length of the dental arch, as well as the mesio-distal dimension of the tooth, i.e., the overall width of the incisors.

The results of this research confirm the previously described characteristics typical of Class III. The sum of mandibular incisors in the examined sample is significantly higher, while the sum of maxillary incisors is within the average values. A study conducted in Iraq also indicates that there is a relationship between the development of the dental arch and the size of the teeth and that the sum of mandibular incisors in Class III subjects is greater than the same parameter in Class I occlusion subjects [11].

The mean maxillary sum of incisors is 31.85 mm, while the mean mandibular sum is 22.97 mm. Mean values were also measured in studies in Niš. The result of the mean mandibular sum of incisors in the Niš research was 23.1 mm, while the Novi Sad research obtained slightly higher values of 24.7 mm and 24.9 mm [13–16]. The presented findings also correspond to the anthropological measurements conducted in Republika Srpska, where the measured mandibular sum of incisors was 22.88 mm [17]. The mean values of the maxillary sum of incisors in the same studies ranged from 30.17 mm to 32.12 mm [14, 15].

Numerous studies have come to the conclusion that prognathism inhibits the development of the upper jaw and the upper dental arch to a greater or lesser extent [11]. The values of our research, such as the lower value of the upper dental arch posterior width, as well as the lower value of the maxillary apical base to the dental arch ratio, point to a lower development of the upper jaw.

Studies in Niš, Korea and Turkey indicate that people with Class III malocclusion have a significantly smaller maxillary dental arch size [18–21]. Measurements of the anterior and posterior width of the dental arches in numerous studies in America, Turkey and Croatia also show significantly greater development of the lower dental arches [21–24].

A statistically significantly higher ratio of the mandibular apical base and arch length is also one of the characteristics of Class III malocclusion, which was confirmed by our research. It is believed that due to the lingual inclination of the lower teeth, the outer surface of the mandibular base forms a larger arch and this determines the longer length of the apical base compared to the length of the dental arch [25].

Moreover, the ratio of the maxillary and mandibular apical base is very low, as it is at the lower threshold of the Rees interval and very close to statistical significance (p = 0.09), which also indicates a greater development of the lower jaw and dental arch.

Similar studies by other authors mostly confirm our results. Greater dimensions of the dental arch in individuals with Class III malocclusion were obtained in Korea and China [19, 20, 26].

It is considered that the dimensions of the dental arches are largely determined by the size of the teeth, so it can be concluded that the size of the teeth as well as the dimensions and shape of the dental arches indicate available space in the jaw, the prognosis of esthetics and results of the therapy, and that they largely guide the diagnosis and therapy plan in orthodontics.

The limiting factor of this study is the fact that there were only a few relevant data from the research conducted in the last 5 years that we could compare our results to.

Conclusion

The research showed that Class III malocclusion is statistically significantly different compared to average values in accordance with the following characteristics:

– Greater sum of mandibular incisors

– Smaller anterior width of both dental arches
– Smaller posterior width of the maxilla
– Smaller maxillary length of the apical base to the dental arch ratio
– Greater mandibular length of the apical base to the dental arch ratio.

No correlation was established between the corresponding parameters of the upper and lower jaw.

References

1. Proffit WR, Fields HW, Larson BE, Sarver DM. Contemporary orthodontics. 6th ed. Philadelphia: Elsevier; 2019.

2. Stojanović Z, Brkić Z, Vučinić P, Nikolić P, Marjanović M. Correlation between sagittal jaw position and jaw relationship in children with skeletal Class III malocclusion. Srp Arh Celok Lek. 2018;146(1-2):12-9.

3. Marić D, Vukić-Ćulafić B. Praktikum iz ortodoncije. Novi Sad: Medicinski fakultet Novi Sad; 2003. 4. Milinković M, Ivanović T, Nikolić P, Stojanović Lj, Milosavljević Ž, Samardžija Hrisa J, et al. Frequency of malocclusion and condition of dental health among eight-year-old children in the municipality of Foča. Serbian Dental Journal. 2018;65(3):133-9.

5. Redzepagic Vrazalica L, Ilic Z, Laganin S, Dzemidzic V, Tiro A. An epidemiological study of malocclusion and occlusal traits related to different stages of dental development. South European Journal of Orthodontics and Dentofacial Research. 2017;4(1):9-13.

6. De Ridder L, Aleksieva A, Willems G, Declerck D, de Llano-Perula MC. Prevalence of orthodontic malocclusions in healthy children and adolescents: a systematic review. Int J Environ Res Public Health. 2022;19(12):7446.

7. Al-Hilal LH, Sultan K, Hajeer MY, Mahmoud G, Wanli AA. An evaluation of mandibular dental and basal arch dimensions in Class I and Cass II division 1 adult Syrian patients using cone-beam computed tomography. J Contemp Dent Pract. 2018;19(4):431-7.

8. Radumilo D, Vučinić P, Ivić S, Petrović Đ. The importance of lip muscle activity in determining the position of the anterior teeth in deep bite. Med Pregl. 2021;74(7-8):244-8.

9. Zawawi KH, Alsulaimani FF, Al-Dharrab AA, Afify AR, Al-Zahrani MS, Baeshen HA. Morphological features of Class I, II, III malocclusions of Saudi adolescents. Saudi J Biol Sci. 2021; 28(6):3534-9.

10. Zere E, Chaudhari PK, Sharan J, DhingraK, Tiwari N. Developing Class III malocclusions: challenges and solutions. Clin Cosmet Investig Dent. 2018:10;99-116.

11. Noor FK, Ausama A. Alveolar base and dental arch widths with segmental arch measurements in different classes of malocclusions. Journal of Baghdad College of Dentistry. 2011;23(3):130-6.

12. Jezdić ZM. Uticaj bimaksilarne hirurške korekcije mandibularnog prognatizma na mekotkivne strukture lica [dissertation]. Beograd: Univerzitet u Beogradu, Stomatološki fakultet; 2016.

13. Jakšić T, Ivić S. Pouzdanost Mojersove gnatometrijske analize u populaciji stanovništva Vojvodine. Medicina danas. 2012;11(1-3):48-53.

14. Milošević N, Ivić S. Vrednosti Tonnovog indeksa populacije Vojvodine. Medicina danas. 2013;12(4-6):71-7.

15. Janošević M, Filipović G, Stanković S, Tričković Janjić O. Influence of the size of incisors on the occurrence of crowding. Facta Universitatis Series Medicine and Biology. 2006;13(1):36-43.

16. Filipović G, Janošević M, Stošić M. Interarch tooth size discrepancy in subjects with Class III malocclusion. Acta stomatologica Naissi. 2008;24(57):755-65.

17. Umićević-Davidović M, Arbutina A, Arapović-Savić M, Marin S. Procena veličine neizniklih stalnih očnjaka i premolara u mešovitoj denticiji. Glasnik Antropološkog društva Srbije. 2012;47:17-25.

18. Filipović G, Janošević M, Stošić M, Stojanović D, Tričković-Janjić O. Arch widths in Class III malocclusion. Acta stomatologica Naissi. 2009;25(59):843-50.

19. Lee HK, Son WS. A study on basal and dental arch width in skeletal Class III malocclusion. Korean J Orthod. 2002;32(2):117-27.

20. Park HC, Lee JW. Study of horizontal skeletal pattern and dental arch in skeletal Class III malocclusion patients. Korean J Orthod. 2008;38(5):358-70.

21. Uysal T, Usumez S, Memili B, Sari Z. Dental and alveolar arch widths in normal occlusion and Class III malocclusion. Angle Orthod. 2005;75(5):809-13.

22. Kunz TR, Stalez RN, Bigelow HF, Kremenak CR, Kohout FJ, Jakobsen JR. Arch width in adults with Class I crowded and Class III malocclusions compared with normal occlusions. Angle Orthod. 2008;78(4):597-603.

23. Šlaj M, Spalj S, Pavlin D, Illes D, Slaj M. Dental archforms in dentoalveolar Class I, II and III. Angle Orthod. 2010;80(5):919-24.

24. Šlaj M, Ježina M, Lauc T, Rajić-Meštrović S, Miksić M. Longitudinal dental arch changes in mixed dentition. Angle Orthod. 2003;73(5):509-14.

25. Jokić D, Bagatin M, Muretić Ž. Maksilarni retrognatizam: ortodontsko i kiruško liječenje. Acta Stomatol Croat. 1997;31(4):381-8.

26. Chen F, Terada K, Wu L, Saito I. Dental arch widths and mandibular-maxillary base width in Class III malocclusion with low average and high Mp-SN angles. Angle Orthod. 2001;77(1):36-41.

Rad je primljen 23. XII 2022.
Recenziran 10. I 2023.
Prihvaćen za štampu 11. I 2023.
BIBLID.0025-8105:(2022):LXXV:9-10:279-283.