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MANDIBULARNE ASIMETRIJE KOD PACIJENATA SA SKELETNIM KLASAMA I I II: KVANTITATIVNA ANALIZA I KOMPARACIJA

MANDIBULAR ASYMMETRIES IN PATIENTS WITH SKELETAL CLASSES I AND II: AN ANALYSIS AND COMPARISON

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Sažetak

Uvod: *Mandibularne asimetrije su česte kod ortodontskih pacijenata i utiču na estetiku lica i funkcije orofacialnog predela.*
Cilj *ovog istraživanja bio je da se analizira prevalencija i stepen mandibularnih asimetrija kod pacijenata sa skeletnim klasama I i II, koristeći ortopantomografske (OPG) snimke za procenu linearnih i angularnih parametara mandibule.*
Materijali i Metode: *Analizirano je 70 ortopantomografskih snimaka pacijenata starijih od 16 godina. Pacijenti su klasifikovani u grupe sa skeletnom klasom I i II na osnovu analize lateralnih kefalometrijskih snimaka. Linearna i angularna merenja mandibule kategorizovana kao blaga, umerena, izražena ili teška asimetrija.*
Rezultati: *Bez obzira što nisu pronađene značajne statističke razlike između pacijenata sa skeletnim klasama I i II u pogledu dužine ramusa, dužine korpusa mandibule ili asimetrije gonijalnog ugla postoji dominacija skretanja mandibule u levu stranu. Uzimajući u obzir razlike u dužini mandibularnog ramusa i korpusa, ukupno 19 učesnika (27,14%) – 10 u skeletnoj Klasi I i 9 u Klasi II – imalo je razlike manje od 2 mm za obe merene vrednosti. Preostalih 51 učesnik imalo je bar jednu merenu razliku veću od 2 mm, što ukazuje na to da mandibulofacijalna asimetrija jeste problem često prisutan u okviru analiziranih grupa.*
Zaključak: *Studija nije pokazala značajne razlike u mandibularnim asimetrijama između pacijenata sa skeletnim klasama I i II, naglašavajući značaj procene asimetrije kod svih ortodontskih pacijenata radi efikasnog planiranja tretmana.*

Ključne reči: *mandibularna asimetrija, dužina ramusa, dužina korpusa, gonijalni ugao, skretanje mandibule*

Abstract

Introduction: *Mandibular asymmetries are common in orthodontic patients and affect both aesthetics and function.*
The aim *of this study was to analyze the prevalence and degree of mandibular asymmetries in patients with skeletal Classes I and II, using orthopantomographic (OPG) images to assess linear and angular measurements of the mandible.*
Materials and Methods: *A total of 70 orthopantomographic images of patients over 16 years of age were analyzed. Patients were classified into skeletal Class I and II groups based on lateral cephalometric analysis. Linear and angular mandibular measurements were categorized as mild, moderate, pronounced, or severe asymmetry.*
Results: *Although no statistically significant differences were found between skeletal Class I and II patients in terms of ramus length, mandibular corpus length, or gonial angle asymmetry, there was a predominant deviation of the mandible to the left side. Considering differences in the length of the mandibular ramus and corpus, a total of 19 participants (27.14%)—10 in skeletal Class I and 9 in Class II—had differences of less than 2 mm for both measured values. The remaining 51 participants had at least one measured difference greater than 2 mm, indicating that mandibulofacial asymmetry is a common issue within the analyzed groups.*
Conclusion: *The study did not show significant differences in mandibular asymmetries between patients with skeletal Classes I and II, highlighting the importance of asymmetry assessment in all orthodontic patients for effective treatment planning.*

Key words: *mandibular asymmetry, ramus length, corpus length, gonial angle, mandibular deviation*

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Introduction

Orthodontic treatment transcends mere dental alignment—it serves as a powerful tool in sculpting facial harmony, a cornerstone of modern clinical aesthetics. Through strategic tooth movement, orthodontic therapy brings about nuanced yet significant changes in facial appearance. Variations in facial appearance are numerous and depend on genetic factors, sex, and evolutionary processes[1]. Differences in tooth position, occlusal relationship, skeletal growth patterns, and the thickness of facial soft tissues all shape an individual's facial appearance and identity.

A significant part of orthodontic diagnostics is dedicated to facial analysis. Numerous parameters are evaluated within this analysis, but the assessment often begins with the transverse dimension and the evaluation of symmetry. It is generally considered that facial beauty is directly linked to the degree of facial symmetry. However, perfect symmetry remains a theoretical concept, as minor morphological differences between the left and right sides are natural. Functional asymmetry, alongside morphological asymmetry, is widely recognized in clinical practice[2].

The face often shows mild asymmetry, known as relative, subclinical, or normal asymmetry, which typically goes unnoticed[2]; it may even contribute to a more natural appearance[3]. More pronounced asymmetries, however, are noticeable and can negatively impact facial aesthetics[4–7]. Anthropological and cephalometric studies have confirmed the presence of asymmetries as part of normal facial variation[8–10] and as a common occurrence at certain stages of development[11,12].

Asymmetries of the lower third of the face are far more common than those of the midface, primarily because the mandible is highly mobile, serves as the main skeletal support for the soft tissues of this region, and the mandible has a lengthier growth period than the maxilla[13,14]. Proffit noted that in 75% of patients with facial asymmetry, chin deviation is present, while midfacial asymmetry is observed in 36% of cases. Upper third facial asymmetry is noticeable in only 5% of these patients[14].

In the differential diagnosis of asymmetries, alongside clinical examination, radiographic imaging in various projections is carried out (orthopantomography (OPG), lateral cephalometric radiograph, posteroanterior (A)] radiograph). Modern radiographic techniques enhance diagnostic capabilities but also increase radiation exposure. Lateral cephalometric radiographs are insufficient for diagnosing asymmetries because they are not suitable for analyses in the transverse plane. Orthopantomograms, however, allow for bilateral visualization and accurate measurements, provided the patient is correctly positioned[15,16]. They offer insight into the condition of the teeth and bony structures of the maxilla and mandible, enabling comparisons of the shape and size of the ramus, corpus, and condyle[16].

The aim of this study was to analyze OPG of patients over the age of 16 without syndromes or deformities to determine the prevalence of mandibular asymmetries and the degree of mandibular deviation in patients at the Clinic of Dental Medicine in Niš. Due to the retrognathic position of the mandible and chin in patients with a Class II skeletal relationship, asymmetries may appear less noticeable compared to patients with a Class I or Class III skeletal relationship. This study was designed to compare the severity and prevalence of mandibular asymmetries between patients with Class I and Class II skeletal relationships. Linear and angular measurements on orthopantomographs allow for a more precise evaluation and a better understanding of these asymmetries in the examined population.

Materials and Methods

Ethical approval of the study was obtained from the Ethical Committee of the Clinic for Dental Medicine in Niš with reference No. 14/6-2023-2 EO. It was a retrospective cross-sectional study. This study reviewed over 300 patient records and OPG radiographs of patients with skeletal Class I and Class II malocclusions, aged 16 years and older, from the diagnostic database of the Department of Orthodontics at the Clinic for Dental Medicine in Niš. Skeletal classification was determined using patients' lateral cephalometric (Tl-Rö) radiographs prior to the start of orthodontic treatment, based on ANB angle values and Wits appraisal. Following the inclusion criteria, out of the 300 reviewed cases, 70 OPG radiographs (26 male, 44 female) were finally included in the study. These patients had no history of trauma, or orthodontic treatment recorded in their medical history. Patients with syndromes or craniofacial deformities were excluded from the study. Only OPG radiographs without artifacts, with a complete display of the mandible, without distortion, and with good radiographic contrast were included.

OPG radiographs were obtained under standardized conditions using the same equipment Sirona Axeos CBCT Ceph (Sirona Dental System GmbH, Bensheim, Germany) and Sidexis 4 software, Galileos Viewer (Dentsply Sirona, USA). Radiographs meeting the inclusion criteria were manually traced on tracing paper made of lacquered polyester acetate (A4 size, 90 g/m²) using a 0.50 mm technical pencil. The tracing and measurement methodology was adOPGed from Gupta et al.[17]. All the measurements of the profile image were performed by the same examiner. The analysis of 20 profile images was repeated after two weeks in order to ensure reliability. Intra-class correlation coefficients were performed to assess the reliability of the measurements. The values of reliability coefficients were found to be greater than 0.91 for all the variables.

The following anatomical landmarks were traced: orbitale (Or), spina nasalis anterior (SNA), condylion (Co), gonion (Go) and menton (Me). The horizontal plane was determined by connecting the orbital points, while two vertical planes were drawn perpendicular to the bi-orbital horizontal plane—one passing through the SNA point and the other through the projection of the spina mentalis onto the lower border of the mandible (Me point). To assess mandibular deviation, the angle between the SNA plane and the line connecting the SNA and Me points was traced and measured (Figure 1).The linear measurements performed included the ramus length (Co–Go) and the mandibular corpus length (Go–Me), comparing the left and right sides[17].

The angular measurements included the gonial angle (intersection of the tangents to the ramus and the corpus of the mandible) and the mandibular deviation angle (SNA–Me), where the angle formed between the vertical SNA plane and the line connecting SNA and Me was measured and expressed in degrees. A deviation to the right side was recorded as a negative value, while a deviation to the left side was recorded as a positive value[18,19].

Asymmetry classification involves several measurements to evaluate the differences in facial structure. For linear asymmetry, the difference in the Co–Go length (left vs. right side) is classified as follows: a difference of 0–1.9 mm is considered mild, 2–2.9 mm is moderate, 3–4.9 mm is pronounced, and a difference of ≥ 5 mm is categorized as severe asymmetry. Similarly, the difference in the Go–Me length (left vs. right side) follows the same classification: 0–1.9 mm (mild), 2–2.9 mm (moderate), 3–4.9 mm (pronounced), and ≥ 5 mm (severe asymmetry).

For angular asymmetry, the classification is based on the difference in the left and right gonial angles: a difference of 0°–2.99° is mild, 3°–5° is moderate, 5°–10° is pronounced, and a difference greater than 10° is classified as severe. Finally, mandibular deviation is assessed according to the mandibular deviation angle values: 0° is considered no deviation, 0.1°–1.9° is mild, 2°–3.9° is moderate, and values greater than 4° are classified as pronounced.

Data were analyzed using IBM SPSS v27.0 software. The Kolmogorov–Smirnov test was used for assessing normality of distribution, followed by the Student's t-test, Mann–Whitney U test, and Chi-square test, with a significance level set at $p < 0.05$.

Results

The study included 70 panoramic radiographs (OPG) of patients (44 females and 26 males) with an average age of 20.44 ± 4.29 years. Participants were classified based on the skeletal sagittal relationship of the jaws: 35 subjects with skeletal Class I and 35 subjects with skeletal Class II.

In the analysis of linear and angular measurements, Student's t-test showed no statistically significant difference in the length of the mandibular ramus (Co−Go), corpus length (Go−Me), and gonial angle (Go Angle) between the left and right sides with respect to skeletal class ($p > 0.05$). No significant differences were found when linear measurements were compared according to sex, nor for differences in gonial angle values between male and female subjects ($p < 0.05$, Table 1).

Regarding the difference in mandibular ramus length between the left and right sides in the total sample, the majority of participants, 36 (51.43%), had no significant difference or a difference less than 1.9 mm, thus classified into the first group. Only 4 participants (5.71%) had a difference greater than 5 mm, with the maximum recorded difference being 6 mm (Graph 1).

Analyzing the difference in mandibular ramus length between the left and right sides among participants with skeletal Class I, it was found that 17 participants (48.57%) had a difference less than 1.9 mm, while 3 participants (8.57%) had a difference greater than 5 mm. Among participants with skeletal Class II, 19 subjects (54.29%) were classified into the group with a difference less than 1.9 mm, and only 1 subject (2.86%) had a difference greater than 5 mm (Graph 1).

Regarding the difference in mandibular corpus length between the left and right sides in the total sample, the largest number of participants, 33 (47.14%), had a difference greater than 5 mm, thus classified into the group of severe asymmetries, with the maximum recorded difference reaching 18 mm; however, statistical analysis showed that the difference between sides was not significant (Graph 2).

Analyzing the difference in mandibular corpus length among participants with skeletal Class I, 18 participants (51.43%) had a corpus length difference greater than 5 mm, while 8 participants (22.86%) had a difference less than 1.9 mm. In the skeletal Class II group, 15 participants (42.86%) had a difference greater than 5 mm, and 6 participants (17.14%) had a difference less than 1.9 mm (Graph 2).

Considering differences in both mandibular ramus and corpus length, a total of 19 participants (27.14%), 10 in skeletal Class I and 9 in Class II, had differences less than 2 mm for both measured values. The remaining 51 participants had at least one measured difference greater than 2 mm, indicating more pronounced mandibulofacial asymmetry.

In the analysis of differences in left and right gonial angles within the total sample, participants were divided into four groups based on the magnitude of the difference. The majority of subjects, 51 (72.86%), belonged to the first and second groups, classified as having mild asymmetry, while 3 cases (4.29%) were recorded in the fourth group with differences greater than 10 degrees. One subject exhibited a difference of as much as 18 degrees between the left and right angles (Graph 3).

Statistical data on differences in ramus length (Co−Go), mandibular corpus length (Go−Me), and gonial angle size between the right and left sides showed that the mean values for the right side were slightly greater than those for the left, but without statistical significance (Table 2).

When comparing the values between the left and right sides for males and females, the following mean differences were obtained for male subjects: Co−Go 1.78 mm (± 1.31), Go−Me 4.59 mm (± 3.47), Go Angle 3.96° (± 2.59). For female subjects, the mean differences were: Co−Go 1.81 mm (± 1.40), Go−Me 4.89 mm (± 4.09), Go Angle 3.53° (± 3.68) (Table 2).

Analysis of the differences in the measured parameters between the left and right sides between patients with skeletal Class I and Class II did not show any statistically significant differences for Co−Go, Go−Me, or Go Angle (Table 2).

The distribution of mandibular deviation angles across the total sample showed that 24 participants (34.29%) exhibited mandibular deviation to the right, while 37 participants (52.86%) deviated to the left, and 9 participants (12.86%) showed no deviation (Graph 4). When looking at skeletal Class I participants, 13 (37.14%) had a rightward mandibular deviation, while 20 (57.14%) deviated to the left. In the skeletal Class II group, 11 participants (31.43%) displayed rightward deviation, and 17 (48.57%) showed leftward deviation (Graph 4).

Statistical analysis of the mandibular deviation angle (Chi-square test) showed no significant difference either between sexes in the distribution of skeletal classes ($\chi^2 = 0.110$, $p = 0.804$) or in the direction of mandibular deviation ($\chi^2 = 1.181$, $p = 0.307$).

Table 1. Mean values with SD of ramus length, corpus length, and gonial angles by side

	Side		Statistical significance (p)
	Right	Left	
Co−Go	61.72 ± 6.03	60.83 ± 5.82	0.374
Go−Me	95.37 ± 8.24	95.41 ± 8.32	0.980
Go Angle	125.15 ± 7.81	126.79 ± 7.90	0.220

Table 2. Mean values of differences between left and right side in ramus length, corpus length, and gonial angles by gender, and skeletal class

Parameter	Male (±SD)	Female (±SD)	p-value	Class I (±SD)	Class II (±SD)	p-value
Co–Go	1.78 ± 1.31	1.81 ± 1.40	0.931	1.83 ± 1.57	1.79 ± 1.14	0.896
Go–Me	4.59 ± 3.47	4.89 ± 4.09	0.763	4.49 ± 3.29	5.07 ± 4.36	0.528
Go Angle	3.96 ± 2.59	3.53 ± 3.68	0.579	3.83 ± 3.11	3.56 ± 3.09	0.715

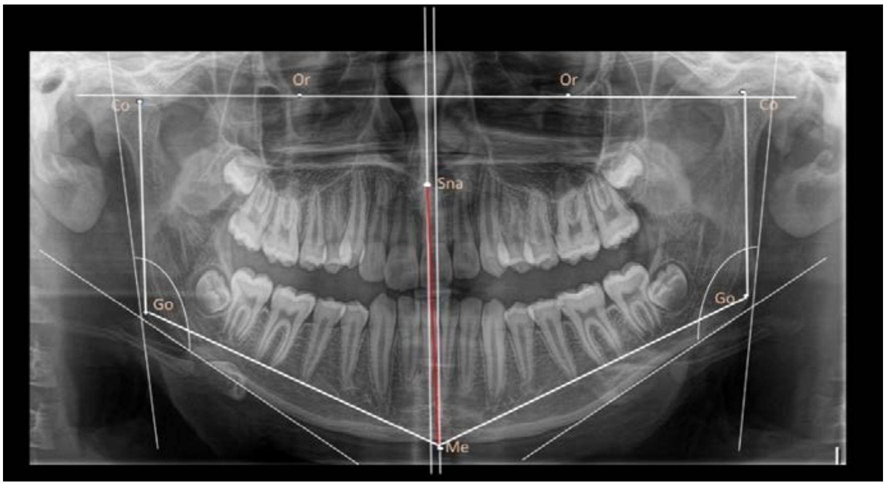
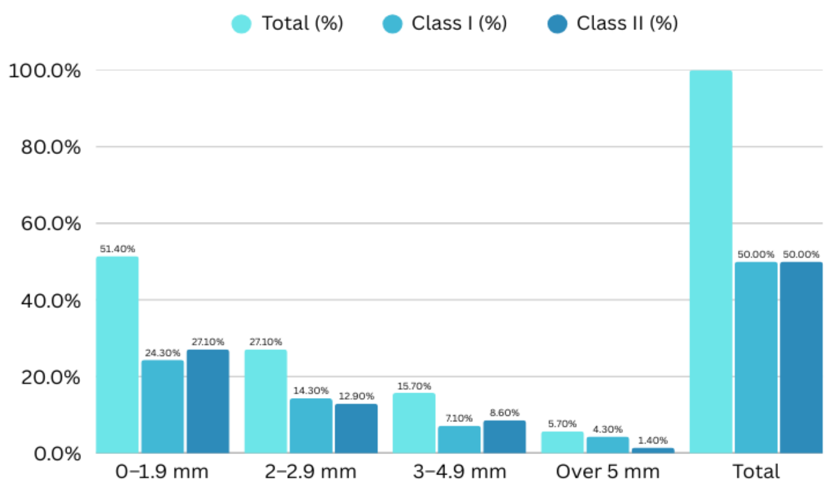
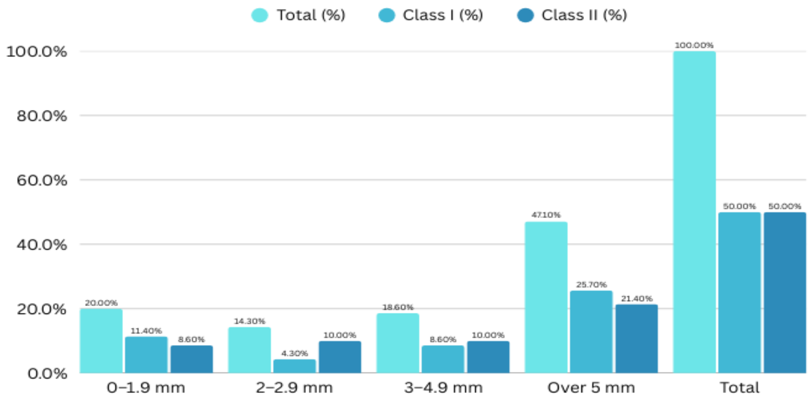


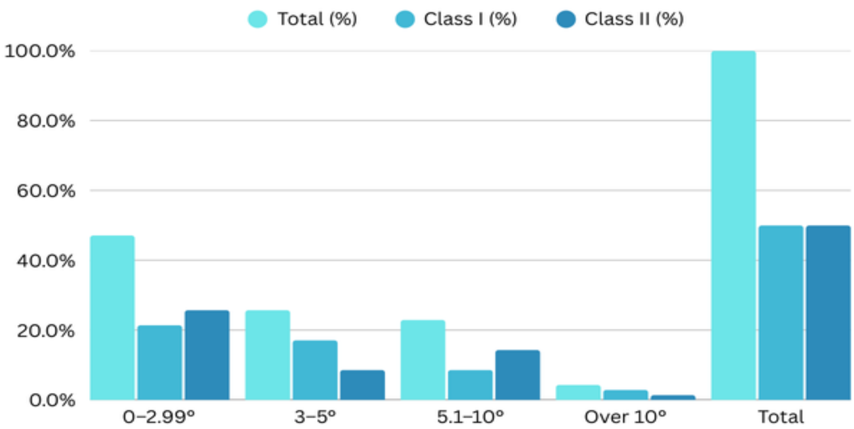
Figure 1. Example of an orthopantomogram with marked points, planes, and angles



Graph 1. Distribution of differences in the length of the mandibular ramus between the left and right sides according to the degree of asymmetry difference 0–1.9 (mild), difference 2–2.9 (moderate), difference 3–4.9 (pronounced), difference ≥ 5 (severe asymmetry)



Graph 2. Distribution of differences in the length of the mandibular corpus between the left and right sides according to the severity of the asymmetry difference 0–1.9 (mild), difference 2–2.9 (moderate), difference 3–4.9 (pronounced), difference ≥ 5 (severe asymmetry)



Graph 3. Distribution of differences in the gonial angle between the left and right sides according to the severity of the asymmetry difference 0°–2.99° (mild), difference 3°–5° (moderate), difference 5°–10° (pronounced), difference > 10° (severe)

Graph 4. Distribution of differences in the mandibular deviation angle according to the severity of the deviation deviation degree 0° (no deviation), 0.1°–1.9° (mild), 2°–3.9° (moderate), > 4° (pronounced)

Discussion

Facial symmetry is considered a crucial factor in determining facial attractiveness, as highlighted by numerous studies[14]. Given that asymmetries are more commonly observed in the lower third of the face than in the midface, many studies have focused on determining the prevalence of mandibular asymmetries in orthodontic patients. It is important to note that mandibular asymmetries in young patients are sometimes considered merely a phase of growth; therefore, most available literature focuses on adults[7,20]. Recently, there has been a growing interest in determining the degree and prevalence of mandibular asymmetries in relation to sagittal and vertical malocclusions, with patients with Class III malocclusion being the most extensively studied group[21,22].

Evangelista et al.[23], based on a systematic literature review, indicated that mandibular asymmetries are more common in Class III malocclusion compared to Class I and II. According to the literature included in their analysis, deviation of the chin to one side in Class I skeletal pattern ranges from 17.66% up to 55.6% of cases. In Class II skeletal pattern, chin deviation occurs in 10% to 25.5% of cases. The particular interest of researchers in asymmetries in Class III patients is due to the pronounced mandibular and chin prominence, which aesthetically emphasizes the asymmetry problem. In Class II malocclusion, the chin is positioned distally, making mandibular asymmetry less dominant. Within different malocclusions, especially sagittal ones, there are significant morphological variations of the mandibular base[21,24], which is one of the reasons why in our study we focused only on patients with Class I and II skeletal patterns.

Majeed et al.[25] conducted a study on 171 panoramic radiographs divided into Class I, II, and III skeletal groups, examining mandibular asymmetry at the level of the condyle and ramus. They concluded that although there are significant differences in condylar height among groups with different sagittal skeletal relationships, no statistically significant differences were found regarding mandibular asymmetry between the groups. Similar results were reported by Shireen et al.[24], who also did not find significant differences in ramus height asymmetry between patients with Class I and II skeletal patterns. These findings align with our results.

In contrast to these authors[26], Yu Wang et al. emphasized that there are significant differences in mandibular and gonial angle asymmetry between Class I and Class II skeletal patterns. They reported that asymmetry of the gonial angle is more frequent in patients with Class I skeletal pattern, which does not correspond with our findings regarding gonial angle asymmetry in Class I and II. However, it is important to consider that our research was conducted using 2D panoramic radiographs, while their study utilized 3D imaging.

Panoramic radiographs have limitations, such as image superimposition, varying magnifications, and distortions. Cone-beam computed tomography (CBCT) is a more advanced and accurate technology that can compensate for these limitations of 2D imaging, so the differences in obtained results may stem from the different methodologies. Additionally, mandibular asymmetry is inherently a three-dimensional issue, and reducing it to two dimensions carries inherent risks in interpreting linear and angular parameters.

Lower facial asymmetry is most commonly associated with chin deviation to the right or left side. According to Ting Dong et al.[27], both orthodontists and non-dental professionals clearly perceive these types of transverse deviations and consider them to significantly impair facial attractiveness.

Severt and Proffit[14] reported that in the North Carolina population, mandibular (chin) deviation is more often to the left than to the right, which is consistent with our results indicating a predominance of leftward chin deviation in both Class I and Class II skeletal patterns.

Another interesting finding of our study was the absence of predominantly present asymmetry on either side, as the measured average values with standard deviations were approximately equal. Other studies have reported that the right side tends to dominate over the left[7,28]. Based on our findings, it cannot be generalized that the right side dominates in the examined groups. Nevertheless, therefore the second part of the results is somewhat paradoxical, as it clearly shows that the majority of patients exhibited leftward chin deviation.

Our results are in line with studies suggesting that mandibular dimensional asymmetries are independent of gender[29,30].

Lu[31,32] and Kula[7] reported that mandibular linear asymmetries greater than 2–3 mm can affect facial appearance, whereas Skvarilová[28] considered a range of 4 to 5 mm as a normal asymmetry of facial dimensions. In our study, pronounced asymmetry was defined as a 3–5 mm difference between the sides of the mandible, and severe asymmetry as greater than 5 mm.

Out of a total of 70 participants, 12 had pronounced ramus length (Co−Go) asymmetry, and 4 had severe asymmetry. Regarding the length of the mandibular corpus (Go−Me), 13 participants had pronounced asymmetry, while 33 had severe asymmetry. At the overall sample level, only 3 patients had an asymmetry greater than 5 mm in both ramus and corpus dimensions.

Only a few studies have examined angular asymmetries in the craniofacial complex. Some studies reported no statistically significant differences in gonial angle measurements between the sides[31,32]. The results of our study are contrary to these findings. It was determined that 18 patients had a gonial angle difference between 3 and 5 degrees, 16 had a difference between 5.1 and 10 degrees, and 3 patients had a difference greater than 10 degrees. This shows that more than half of the participants exhibited moderate, pronounced, or severe asymmetry when comparing left and right gonial angles.

A limitation of the present study is that it was conducted using two-dimensional radiographs, and no further classification of Class II patients into subgroups was performed.

Conclusion

There are no statistically significant differences between the left and right sides of the mandible in terms of ramus length (Co−Go), corpus length (Go−Me), and gonial angle (Go Angle) between patients with Class I and Class II skeletal patterns.

Statistical data on differences in ramus length (Co−Go), corpus length (Go−Me), and gonial angles (Go Angle) between the right and left sides showed that mean values for the right side were slightly higher than those for the left.

The majority of patients exhibited leftward mandibular deviation in both Class I and Class II skeletal patterns.

Considering differences in both mandibular ramus and corpus length, a total of 19 participants (27.14%), 10 in skeletal Class I and 9 in Class II, had differences less than 2 mm for both measured values. The remaining 51 participants had at least one measured difference greater than 2 mm, indicating more pronounced mandibulofacial asymmetry.

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Conflict of Interest: Nil

LITERATURA/REFERENCES

1. Lindauer SJ. Asymmetries: diagnosis and treatment. Seminars in orthodontics. 1998/11/10 ed. 1998 Sep;4(3):133.
2. Thiesen G, Gribel BF, Freitas MP. Facial asymmetry: a current review. Dental press journal of orthodontics. 2015/12/23 ed. 2015 Nov;20(6):110–25.
3. Lu SM, Bartlett SP. On facial asymmetry and self-perception. Plast Reconstr Surg. 2014 Jun;133(6):873e–81e.
4. Nanda R, Margolis MJ. Treatment strategies for midline discrepancies. Seminars in orthodontics. 1996/06/01 ed. 1996 Jun;2(2):84–9.
5. Burstone CJ. Diagnosis and treatment planning of patients with asymmetries. Seminars in orthodontics. 1998/11/10 ed. 1998 Sep;4(3):153–64.
6. Lu KH. Harmonic analysis of the human face. Biometrics. 1965/06/01 ed. 1965 Jun;21:491–505.
7. Kula K, Esmailnejad A, Hass A. Dental arch asymmetry in children with large overjets. The Angle orthodontist. 1998/03/21 ed. 1998 Feb;68(1):45–52.
8. Mulick JF. An investigation of craniofacial asymmetry using the serial twin-study method. American journal of orthodontics. 1965/02/01 ed. 1965 Feb;51:112–29.
9. Letzer GM, Kronman JH. A posteroanterior cephalometric evaluation of craniofacial asymmetry. The Angle orthodontist. 1967/07/01 ed. 1967 Jul;37(3):205–11.
10. Vig PS, Hewitt AB. Asymmetry of the human facial skeleton. The Angle orthodontist. 1975/04/01 ed. 1975 Apr;45(2):125–9.
11. Melnik AK. A cephalometric study of mandibular asymmetry in a longitudinally followed sample of growing children. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 1992/04/01 ed. 1992 Apr;101(4):355–66.
12. Duthie J, Bharwani D, Tallents RH, Bellohusen R, Fishman L. A longitudinal study of normal asymmetric mandibular growth and its relationship to skeletal maturation. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 2007/08/19 ed. 2007 Aug;132(2):179–84.
13. Sheats RD, McGorray SP, Musmar Q, Wheeler TT, King GJ. Prevalence of orthodontic asymmetries. Seminars in orthodontics. 1998/11/10 ed. 1998 Sep;4(3):138–45.
14. Severt TR, Proffit WR. The prevalence of facial asymmetry in the dentofacial deformities population at the University of North Carolina. The International journal of adult orthodontics and orthognathic surgery. 1997/01/01 ed. 1997;12(3):171–6.
15. Larheim TA, Svanaes DB, Johannessen S. Reproducibility of radiographs with the orthopantomograph 5: tooth-length assessment. Oral surgery, oral medicine, and oral pathology. 1984/12/01 ed. 1984 Dec;58(6):736–41.
16. Yañez-Vico RM, Iglesias-Linares A, Torres-Lagares D, Gutiérrez-Pérez JL, Solano-Reina E. Diagnostic of craniofacial asymmetry. Literature review. Med Oral Patol Oral Cir Bucal. 2010 May 1;15(3):e494-498.
17. Gupta SK, Saxena P, Jain S, Jain D. Prevalence and distribution of selected developmental dental anomalies in an Indian population. Journal of oral science. 2011/06/30 ed. 2011 Jun;53(2):231–8.
18. Ramirez-Yañez GO, Stewart A, Franken E, Campos K. Prevalence of mandibular asymmetries in growing patients. European Journal of Orthodontics. 2010;33(3):236–42.
19. Nakashima A, Nakano H, Yamada T, Inoue K, Sugiyama G, Kumamaru W, et al. The relationship between lateral displacement of the mandible and scoliosis. Oral and maxillofacial surgery. 2017/01/01 ed. 2017 Mar;21(1):59–63.
20. Liukkonen M, Sillanmäki L, Peltomäki T. Mandibular asymmetry in healthy children. Acta odontologica Scandinavica. 2005/09/30 ed. 2005 Jun;63(3):168–72.
21. Chen YJ, Yao CC, Chang ZC, Lai HH, Yeh KJ, Kok SH. Characterization of facial asymmetry in skeletal Class III malocclusion and its implications for treatment. International journal of oral and maxillofacial surgery. 2019/06/27 ed. 2019 Dec;48(12):1533–41.
22. Tam TKM, Guo R, Liu H, Lin Y. Hard and Soft Tissue Asymmetry in Patients with Skeletal Class III Malocclusion: A Cone-Beam Computed Tomography Study. Diagnostics (Basel, Switzerland). 2023/03/12 ed. 2023 Feb 24;13(5).
23. Evangelista K, Teodoro AB, Bianchi J, Cevidanes LHS, de Oliveira Ruellas AC, Silva MAG, et al. Prevalence of mandibular asymmetry in different skeletal sagittal patterns. The Angle orthodontist. 2021/09/22 ed. 2022 Jan 1;92(1):118–26.
24. siddiqui S, Tikku T, Srivastava K, Verma S, Khanna R. Vertical mandibular asymmetry in angle’s class II subdivision malocclusion. IP Indian Journal of Orthodontics and Dentofacial Research. 11AD;10:240–5.
25. Majeed O, Ahsan T, Habib M, Ashraf A. Mandibular Asymmetry in Orthodontic Patients with Different Malocclusion Patterns an Orthopantomographic Evaluation. Journal of Bahria University Medical and Dental College. 10AD Feb;13:291–5.
26. Wang Y, Wang Y, Wang C, Cao Y, Zhang B, Chen Y, et al. Mandibular asymmetry in patients with skeletal class I and skeletal class II Malocclusions: A cone-beam computed tomography study. Journal of stomatology, oral and maxillofacial surgery. 2023/03/19 ed. 2023 Dec;124(6):101441.
27. Dong T, Ye N, Yuan L, Wu S, Xia L, Fang B. Assessing the Influence of Chin Asymmetry on Perceived Facial Esthetics With 3-Dimensional Images. Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons. 2020/04/19 ed. 2020 Aug;78(8):1389–96.
28. Skvarilová B. Facial asymmetry: type, extent and range of normal values. Acta chirurgiae plasticae. 1993/01/01 ed. 1993;35(3–4):173–80.
29. Ferrario VF, Sforza C, Ciusa V, Dellavia C, Tartaglia GM. The effect of sex and age on facial asymmetry in healthy subjects: a cross-sectional study from adolescence to mid-adulthood. Journal

of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons. 2001/04/06 ed. 2001 Apr;59(4):382–8.

30. Azevedo AR, Janson G, Henriques JF, Freitas MR. Evaluation of asymmetries between subjects with Class II subdivision and apparent facial asymmetry and those with normal occlusion. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 2006/03/11 ed. 2006 Mar;129(3):376–83.
31. Kurt G, Uysal T, Sisman Y, Ramoglu SI. Mandibular asymmetry in Class II subdivision malocclusion. The Angle orthodontist. 2008/01/16 ed. 2008 Jan;78(1):32–7.
32. Kwon TG, Park HS, Ryoo HM, Lee SH. A comparison of craniofacial morphology in patients with and without facial asymmetry--a three-dimensional analysis with computed tomography. International journal of oral and maxillofacial surgery. 2005/06/01 ed. 2006 Jan;35(1):43–8.