ORIGINAL ARTICLE

Relationship between skeletal malocclusion and chin soft tissue thickness in patients: a cross-sectional study

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ABSTRACT

Introduction: Facial aesthetics significantly influence an individual's appearance and attractiveness. The chin is a crucial component of facial profile and personality. Lateral cephalometric radiography is frequently employed to assess the balance between skeletal structure and soft tissue, aiding in facial profile analysis, orthodontic diagnosis, and treatment planning. This study aimed to analyze the relationship between skeletal malocclusion and chin soft tissue thickness in patients. **Method:** A cross-sectional study was employed. The research population comprised lateral cephalograms of orthodontic patients aged 15–28 years, taken at Cimahi Dental Hospital between January 2018 and December 2023. A total of 81 cephalograms were selected using consecutive sampling, based on predefined inclusion and exclusion criteria. These cephalograms were categorized into three malocclusion groups (Angle Class I, II, and III). Soft tissue thickness at the chin was measured from the skeletal to the soft tissue at the Pogonion (Pog-Pog'), Gnathion (Gn-Gn'), and Menton (Me-Me') points. Data were analyzed using ANOVA and the Kruskal-Wallis test. **Results:** No significant correlation was found between skeletal malocclusion and chin soft tissue thickness ($p>0.05$). The ANOVA test yielded a p-value of 0.991 for Gnathion, while the Kruskal-Wallis test showed p-values of 0.918 for Pogonion and 0.698 for Menton. **Conclusion:** There is no relationship between skeletal malocclusion and chin soft tissue thickness among patients at Cimahi Dental Hospital.

KEYWORDS

Chin, soft tissue, thickness, skeletal malocclusion, lateral cephalometry

INTRODUCTION

Facial aesthetics significantly influence an individual's appearance and attractiveness.[1,2] The societal emphasis on perfect facial features to achieve attractiveness often leads individuals to seek aesthetic improvements. However, the balance and harmony of facial structure can be affected by various factors, including genetics, heredity, surrounding facial tissues, dentoskeletal discrepancies, or a combination of these.[3–5] The harmony of the lower face is particularly influenced by both hard and soft tissues, such as the position of the lips and chin.[1,3,6] The chin, in particular, plays a crucial role in an individual's overall appearance and perceived personality.[4,7,8]

One such condition affecting facial harmony is malocclusion. Malocclusion is defined as a disharmony in the position of the teeth and jaws, leading to an imbalance in facial structure.[7,9] In Indonesia, malocclusion prevalence reaches approximately 80%, with rates of 91.26% observed among 12–15-year-olds in Cimahi.[6,7,9] Disparities in the growth of facial soft and hard tissues are attributed to several factors, including gender, age, race, ethnicity, and growth patterns.[8] Subtelny noted that the growth of soft tissue typically accompanies the growth of the underlying hard tissue.[10]

Hard tissue profiles tend to straighten with age, while soft tissue profiles remain relatively stable in their convexity.[11] Maxillary growth can continue up to 15 years of age in females and 18 years in males. Mandibular elongation, conversely, can extend up to 26 mm in males and 20 mm in females between 4 and 20 years of age.[12] Regarding chin soft tissue thickness, it increases by 1.6 mm in females aged 18 years and by 2.4 mm in males of the same age.[3] Notably, males generally possess thicker chin soft tissue than females.[13]

The growth patterns of chin soft tissues are influenced by multiple factors, including age, gender, race and ethnicity.[14] These variations result from factors such as mutation, selection, adaptation, isolation, and migration.[14] The congruence between the facial bone structure and soft tissue can be assessed using cephalometric radiographic examination. This assessment aids in analyzing the facial profile, determining the normality of the orthodontic diagnosis, and formulating the appropriate treatment plan.[15,16] Steiner's lateral cephalometric analysis offers a convenient and efficient method for evaluating skeletal, dental, and soft tissues simultaneously.[16,17]

Steiner skeletal analysis is employed to determine the anteroposterior position of the mandible or maxilla and to evaluate the harmony and balance of an individual's facial profile, aiming for minimal deviation in the cephalogram results.[15,16] Specifically, Steiner analysis utilizes the sella-nasion (SN) plane to point A (SNA angle) to indicate the maxilla's position relative to the skull base. The mandible's position relative to the skull is assessed by the SNB angle, which is formed by the SN and NB lines.[16]

Chin soft tissue analysis is conducted using the Pog-Pog' point, which represents the horizontal distance from the bony pogonion to the soft tissue pogonion; the Gn-Gn' point, which measures the distance from the bony gnathion to the soft tissue gnathion; and the Me-Me' point, which indicates the vertical distance from the bony menton to the soft tissue menton.[18,19] According to Holdaway, the normal value for chin soft tissue thickness is approximately 11.68 ± 2.0 mm.[3] Numerous researchers have reported an association between skeletal malocclusion and mandibular divergence, as well as emphasized the role of orthodontic treatment in enhancing facial aesthetics. However, only a limited number of studies have investigated facial profile imbalance caused by discrepancies in soft tissue thickness, particularly in the chin region. This study aims to analyze the relationship between skeletal malocclusion classification and chin soft tissue thickness in patients.

METHODS

This cross-sectional study was conducted at a dental hospital in Cimahi. It aimed to evaluate the relationship between skeletal malocclusion and chin soft tissue thickness in orthodontic patients who had never undergone previous orthodontic treatment. In this study, Angle's Class I, II, and III skeletal malocclusion classifications, determined via cephalometric tracing, served as the independent variable. The dependent variable was chin soft tissue thickness, measured at the pogonion, menton, and gnathion points. This study hypothesized a significant relationship between skeletal malocclusion and chin soft tissue thickness.

A consecutive sampling was employed, in which samples were collected based on inclusion and exclusion criteria over a specified time period. The samples consisted of 81 standardized lateral cephalometric photographs from the Cimahi Dental Hospital, collected from January 2018 to January 2024. The inclusion criteria were as follows: lateral cephalometric photographs of patients aged 15–28 years who had not undergone orthognathic surgery and had no history of orthodontic treatment. Exclusion criteria included lateral cephalometric photographs of patients with craniofacial anomalies, a history of facial trauma, or congenital defects.

Malocclusion classification was assessed using Steiner analysis. The relationship between the maxilla and the cranial base was determined by assessing the position of point A in relation to the sella-nasion (SN) plane. An SNA value greater than 84° indicates a prognathic maxillary position, while a value less than 80° suggests a retrognathic maxillary position.[20]

The relationship of the mandible to the cranial base is also determined through point B and the sella-nasion (SN) plane. The normal SNB value is 80°±2°; an SNB value greater than 82° indicates a prognathic mandibular position, while a value less than 78° suggests a retrognathic mandibular position.[3,20] The relative anteroposterior relationship between the maxilla and mandible is further evaluated by calculating the difference between the SNA and SNB angles, known as the ANB angle, which typically ranges from 0° to 4°. Skeletal Class I is characterized by an ANB angle of 0-4°. Class II by an ANB angle greater than 4°, Class III by an ANB angle of less than 0°.[20]

Furthermore, to determine the thickness of the chin soft tissue, measurements were taken from the hard tissue to the soft tissue of the chin at three different points: Pogonion (Pog–Pog'), the most anterior point of the chin; Gnathion (Gn–Gn'), located between Pogonion and Menton; and Menton (Me–Me'), the most inferior point of the chin (Figure 1).[3] The average chin soft tissue thickness is approximately 10 ± 2 mm.[21] The term *progenia* refers to a protrusive sagittal position of the pogonion soft tissue (Pog'), while *retrogenia* refers to a retrusive sagittal position.[21,22]

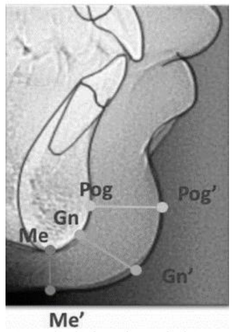

Figure 1. Measurement of chin tissue thickness at Pog, Gn, and Me points.

Research data were recorded in Microsoft Excel, including information on gender, age, malocclusion classification, and chin soft tissue thickness at the Pogonion, Gnathion, and Menton points. A normality test was performed using the Kolmogorov-Smirnov test to determine whether the data were normally distributed. Data with a normal distribution were analyzed using the One-Way ANOVA test, followed by Tukey post-hoc analysis. Data that were not normally distributed were analyzed using the Kruskal-Wallis test, followed by Mann-Whitney post-hoc analysis.

RESULTS

The results of this study are presented in terms of respondent characteristics and the relationship between skeletal malocclusion and chin soft tissue thickness. A total of 81 standardized lateral cephalometric photographs that met the inclusion criteria were collected from patients at Cimahi Dental Hospital. The following section outlines the distribution of respondents by age group, gender, and findings from the statistical data analysis.

As shown in Table 1, the number of female orthodontic patients was higher than that of male patients, with 63.4% being female and 36.6% male. The mean age of the participants was 21.08 ± 4.82 years, with a minimum age of 15 years and a maximum age of 30 years. The largest proportion of patients (46.9%) fell within the 18–25-year age group.

Table 2 presents the average values of chin soft tissue thickness at three anatomical points. At the Pogonion point, the mean soft tissue thickness was 13.25 mm, with a standard deviation of ± 3.35 mm, and values ranged from 7.0

mm to 30.0 mm. At the Gnathion point, the average thickness was 9.73 mm, with a standard deviation of ± 2.75 mm, and values ranged from 4.0 mm to 17.0 mm. Meanwhile, the Menton point exhibited an average thickness of 8.75 mm, with a standard deviation of ± 2.47 mm, and a range of 3.0 mm to 16.0 mm.

Table 1. Characteristics of Research Respondents

Variable	N=81
Gender	
Male	30(36,6%)
Female	52(63,4%)
Age	
Mean ± SD	21,08 ± 4,82
Median	21,00
Range (Min-Max)	16(15-30)
Malocclusion Classification	
Class I	25(30,5%)
Class II	44(53,7%)
Class III	13(15,9%)

Table 2. Analysis of Chin Soft Tissue Thickness in Skeletal Malocclusion Classes I, II, and III

variable	Skeletal Malocclusion			P-Value
	Class I	Class II	Class III	
Pog-Pog'				
Mean ± SD	13,14 ± 2,93	13,38 ± 3,75	13,03 ± 2,83	0,918**
Median	12,50	13,00	13,00	
Range (min-max)	13(10-23)	23(7-30)	10,50(7,50-18)	
Gn-Gn'				
Mean ± SD	9,68 ± 2,14	9,73 ± 3,15	9,80 ± 2,51	0,991*
Median	9,50	9,50	10,00	
Range(min-max)	9,50(5,5 - 15)	13(4-17)	10(6-16)	
Me-Me'				
Mean ± SD	8,96 ± 2,49	8,54 ± 2,59	9,03 ± 2,11	0,698**
Median	8,00	8,25	8,00	
Range(min-max)	10,50(6-16,5)	12(3-15)	7(6-13)	

*Anova Test
**Kruskal-Wallis Test

The average chin soft tissue thickness at the Pogonion point was greatest in Class II malocclusion at 13.38 mm ± 3.75, exceeding values for Class I and Class III. Similarly, the greatest average thickness at the Gnathion point was also observed in the Class II malocclusion group.

The correlation between skeletal malocclusion classification and chin soft tissue thickness at the Gnathion was analyzed using a one-way ANOVA test, yielding a p-value of 0.991 ($p<0.05$). Meanwhile, the correlation between malocclusion classification and soft tissue thickness at the Pogonion and Menton points was assessed using the Kruskal-Wallis test, with p-values of 0.918 and 0.698, respectively. These results indicate that there were no significant differences in chin soft tissue thickness at the Pogonion (Pog), Gnathion (Gn), and Menton (Me) points among the different skeletal malocclusion classifications ($p <0.05$).

DISCUSSION

Facial aesthetics are an important consideration in orthodontic diagnosis and treatment planning.[4] In this study, 63.4% of the sample population were female, which aligns with previous research indicating that male patients tend to be more satisfied with the appearance of their teeth and smile compared to females and younger individuals. This is attributed to the fact that women have a more critical perception of their own appearance.[2] According to Vic Narurka et al., one of the most frequently treated facial areas among women is the chin (24%).[23]

The rising demand for orthodontic treatment among young adults is influenced by modern dental perspectives, societal aesthetic standards, and psychosocial factors. Orthodontic treatment not only enhances self-image but also provides both aesthetic and functional dental health benefits.[24] As a result, female patients generally express a greater desire to improve their dental appearance.[2]

In this study, the average age of participants was 21 ± 4,82 years old (Table 1), which is consistent with findings by Zaudd et al., who reported that both age and gender significantly affect perceptions of dental aesthetics.[2] Orthodontic treatment in adult patients often requires an interdisciplinary approach, making it more complex.[24] Previous studies have indicated that most patients are often unaware that their soft tissue profile is disproportionate due to relative differences in chin position.[4]

Table 2 illustrates that Angle's Class II malocclusion was the most prevalent classification among participants, accounting for approximately 53.7% of the sample, exceeding the incidence of Class I and Class III. This observation is consistent with the demographic characteristics of the Indonesian population, particularly on Java Island, which is predominantly of the Mongoloid race. This is in line with statements suggesting that the facial profile of the Deutro-Malay race, common among the Javanese Tribe, exhibits a more convex or prognathic proportion of the nose, lips, and chin.[6,14] Race and ethnicity are considered influential factors in shaping an individual's facial profile.[3,14]

The facial profile typically increases in convexity until the age of 5-9 years and remains relatively stable between the ages of 9-12 years. From approximately 13 years to adulthood, the facial profile tends to decrease in convexity. This change is primarily attributed to the forward growth direction of the chin's soft tissue and the downward and forward growth of the nose.[25] It is important to note that the position of the teeth does not guarantee that the soft tissue profile of the face will perfectly mirror the hard tissue profile, as the soft tissue covering the teeth and bones can vary significantly.[13]

Table 2 further indicates that chin soft tissue at the Pogonion point is thicker in Class II malocclusion (13.38±3.75 mm) compared to Class I and Class III. Meanwhile, the chin soft tissue at Gnathion (9.80±2.51 mm) and Menton (9.03±2.11 mm) points appears thicker in Class III malocclusion when compared to Class I and II. These findings do not entirely correlate with the previously cited literature suggesting that soft tissue growth generally accompanies the underlying hard tissue.[10,14]

Differences in the growth of facial soft and hard tissues are influenced by several factors, including gender, age, growth patterns, race, and ethnicity.[8] According to Scammon's growth curve, different organs within the body exhibit distinct growth timelines and rates.[22] Changes in the facial profile of females typically occur earlier, between the ages of 10-15 years, whereas in males, these changes usually take place between 15-25 years.[3,22] Specifically, chin soft tissue thickness is reported to increase by 1.6 mm in females and 2.4 mm in males.[3]

Based on the maxillary growth theory, the cranial base can expand up to 15 mm in women and 20 mm in men by the age of 20.[12] Similarly, mandibular elongation can extend up to 26 mm in men and 20 mm in women aged 20 years.[20] These differences in growth timing between hard and soft tissues may be a contributing factor influencing why chin soft tissue thickness does not correlate consistently with each malocclusion classification.[1,3]

Other studies also state that craniofacial growth does not cease immediately in young adulthood but rather continues as a prolonged process until old age, albeit with minor changes. Specifically, the growth of the cranial base is projected to increase by 15 mm in females at the age of 20 and by 20 mm in men at the same age.[22,26,27]

Additional factors contributing to chin soft tissue growth not entirely aligning with the growth of the underlying hard tissue include gender and body mass index (BMI).[28] Notably, males generally possess thicker soft tissue than females.[14] Moreover, soft tissue can develop proportionally or disproportionately to the skeletal structure, depending on the muscle, fat, and skin layers covering the hard tissue.[29] Consequently, an individual's body mass index can increase the thickness of chin soft tissue at Pogonion and Menton points.[14]

Previous studies also mention race and ethnicity as factors affecting differences in chin soft tissue thickness. These differences may stem from patterns of sexual reproduction, matchmaking, and culture.[3,30] For instance, Darkwah et al. reported that cephalometric soft tissue profiles vary significantly across ethnic groups. Specifically, Bangladeshi adults exhibited smaller mandibular planes and reduced lower facial height compared to their Japanese counterparts.[30] Such variations may arise from differing sexual reproduction patterns, matchmaking customs and cultural influences.[3]

Further studies are needed to confirm the differences in chin soft tissue thickness across varying body mass indexes to improve orthodontic diagnosis and treatment planning. However, this study has limitations, particularly a short study period, which resulted in a less than optimal sample size.

CONCLUSION

No significant differences were observed in chin soft tissue thickness at the Pogonion, Gnathion, and Menton points across the three skeletal malocclusion classifications. These findings align with existing theories, such as Scammon's growth curve, which highlight that discrepancies in the growth timing between hard and soft tissues are a primary factor influencing their relationship.

The implications of this research suggest that an individual's facial profile is not solely determined by the positioning of hard tissues but is also significantly influenced by chin soft tissue thickness. This should be a key consideration in orthodontic treatment planning, particularly for educating patients when their facial disharmony stems from disproportionate soft tissues. Providing this information can empower both patients and dentists to determine the most appropriate treatment to enhance facial function and aesthetics.

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Author Contributions:
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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of the Faculty of Medicine, Padjajaran University (N0.1322/UN6.KEP/EC/2023).

Informed Consent Statement: The procedure of this research began with permits at a dental hospital in Cimahi. The informed consent stage was submitted to the person in charge of the medical records at the hospital. Data collection was carried out under the guidance of interprofessional orthodontics. The researcher guaranteed the confidentiality of the data by providing an identity code on the medical records. The medical records were returned to the hospital and did not become the property of the researcher. The measurement results were only used in the research process.

Data Availability Statement: This study was conducted at the Cimahi Dental and Oral Hospital. Measurement data on the medical records of all respondents were archived by the researcher in digital files. If needed for the development of science in the field of orthodontics, the researcher can contact the researcher via email at sharah_safira04@yahoo.co.id. Based on the researcher's commitment stated in the research ethics, the researcher cannot share data information openly.

Conflicts of Interest: We declare that there is no conflict of interest in the scientific articles.

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