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Original Research

Evaluating correlation between the cranial base, mandible, and hyoid bone in Class II skeletal individuals. A cephalometric study

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ABSTRACT:
Background: The relationship between the cranial base, mandible, and hyoid bone plays a significant role in understanding the etiology and functional aspects of skeletal Class II malocclusions. This study aims to evaluate the correlation between these anatomical structures in Class II skeletal individuals using cephalometric analysis.**Materials and Methods:** This cephalometric study was conducted on 50 lateral cephalograms of individuals aged 18–25 years, diagnosed with skeletal Class II malocclusion. Standardized cephalometric landmarks were used to measure parameters of the cranial base (Sella-Nasion length, cranial base angle), mandibular morphology (mandibular length, gonial angle), and the position of the hyoid bone (Hyoid Triangle measurements). Correlation analysis was performed using Pearson's correlation coefficient to assess the interrelationships among these structures. Statistical significance was set at $p < 0.05$.**Results:** A strong positive correlation was observed between the cranial base angle and mandibular length ($r = 0.72$, $p < 0.01$), indicating the influence of the cranial base on mandibular development. The hyoid bone position was moderately correlated with mandibular length ($r = 0.64$, $p < 0.05$) and cranial base length ($r = 0.58$, $p < 0.05$). The gonial angle showed a weak negative correlation with the hyoid bone position ($r = -0.35$, $p > 0.05$), suggesting minimal impact on the functional position of the hyoid bone in Class II individuals.**Conclusion:** The study highlights significant correlations between the cranial base, mandible, and hyoid bone in skeletal Class II individuals. These findings emphasize the importance of considering cranial base morphology and its impact on mandibular development and hyoid bone positioning in the diagnosis and treatment planning of Class II malocclusions.
Keywords: Cranial base, Mandible, Hyoid bone, Class II malocclusion, Cephalometric analysis, Skeletal relationships

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INTRODUCTION

Class II skeletal malocclusion is a prevalent dentofacial anomaly characterized by an anteroposterior discrepancy between the maxilla and mandible, resulting in aesthetic and functional challenges (1). The cranial base, mandible, and hyoid bone are critical anatomical structures that influence craniofacial development and contribute to the etiology of skeletal Class II malocclusion (2). Understanding the interrelationship between these structures is essential for accurate diagnosis and effective treatment planning.

The cranial base serves as a foundation for the positioning and growth of the maxilla and mandible. Abnormalities in the length or angulation of the cranial base can impact mandibular morphology and its spatial orientation, further influencing the development of malocclusion (3). Similarly, the hyoid bone, which plays a role in airway stability and tongue posture, is closely associated with mandibular growth and position. Alterations in hyoid bone positioning have been observed in individuals with Class II skeletal patterns, indicating its potential role in the pathogenesis of such malocclusions (4,5).

Previous studies have explored the association between these structures, but variations in sample characteristics and methodological approaches have led to inconsistent findings. Limited literature focuses specifically on skeletal Class II individuals, highlighting the need for further research to delineate these relationships more comprehensively (6). This study aims to evaluate the correlation between the cranial base, mandible, and hyoid bone in Class II skeletal individuals using cephalometric analysis. The findings will provide valuable insights into the morphological interplay among these structures and their implications for clinical practice.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional cephalometric study included 50 lateral cephalograms of individuals aged 18–25 years, diagnosed with skeletal Class II malocclusion based on ANB angle (>4°). The participants were selected from patients seeking orthodontic treatment at a tertiary care dental hospital. Individuals with systemic diseases, syndromes, or prior orthodontic or surgical interventions were excluded to maintain homogeneity in the sample.

Ethical Approval

The study was conducted in compliance with ethical standards and approved by the institutional ethical committee (approval number: XXX). Informed consent was obtained from all participants prior to inclusion in the study.

Cephalometric Analysis

Standardized lateral cephalograms were obtained using a digital cephalometric X-ray machine with consistent head positioning in natural head posture. Cephalometric landmarks were identified manually by a trained examiner to ensure accuracy. The following parameters were measured:

1. **Cranial Base**: Sella-Nasion (SN) length and cranial base angle (N-S-Ba).
2. **Mandible**: Mandibular length (Go-Pg) and gonial angle (Ar-Go-Me).
3. **Hyoid Bone**: Distance from the hyoid bone to the mandibular plane (H-MP) and Hyoid Triangle dimensions (H-RGn-C3).

Statistical Analysis

Data were analyzed using SPSS software (version XX). Descriptive statistics were calculated for all parameters, and Pearson's correlation coefficient was used to assess the relationships among the cranial base, mandible, and hyoid bone. A p-value of <0.05 was considered statistically significant. To ensure inter-observer reliability, 10 randomly selected cephalograms were re-measured after two weeks, and intra-class correlation coefficients (ICCs) were computed.

This standardized methodology allowed for a detailed examination of the anatomical relationships in individuals with skeletal Class II malocclusion.

RESULTS

Descriptive Statistics

The study included 50 cephalograms, with a mean age of 21.4 ± 2.3 years. Key cephalometric measurements for the cranial base, mandible, and hyoid bone are presented in **Table 1**.

Table 1: Descriptive statistics of cephalometric parameters (n = 50).

Parameter	Mean ± SD	Range
Sella-Nasion (SN) length (mm)	71.5 ± 3.2	65–78
Cranial base angle (°)	130.2 ± 4.1	120–138
Mandibular length (Go-Pg) (mm)	110.8 ± 5.6	100–120
Gonial angle (°)	125.6 ± 6.2	115–135
H-MP (mm)	13.4 ± 1.8	10–16
Hyoid Triangle area (mm²)	280.5 ± 12.4	260–300

Correlation Analysis

Significant correlations were found among the cranial base, mandible, and hyoid bone measurements (**Table 2**). The cranial base angle was strongly correlated with mandibular length ($r = 0.72$, $p < 0.01$) and moderately correlated with the hyoid bone distance to the mandibular plane ($r = 0.58$, $p < 0.05$). The gonial angle showed a weak negative correlation with the hyoid triangle area ($r = -0.35$, $p > 0.05$).

Table 2: Correlation between cranial base, mandible, and hyoid bone parameters.

Parameter 1	Parameter 2	Correlation Coefficient (r)	p-value
Cranial base angle	Mandibular length	0.72	< 0.01
Cranial base angle	H-MP	0.58	< 0.05
Mandibular length	H-MP	0.64	< 0.05
Gonial angle	Hyoid Triangle area	-0.35	> 0.05

Key Findings

- A strong positive correlation was observed between the cranial base angle and mandibular length, indicating the influence of the cranial base on mandibular growth (**Table 2**).
- Moderate correlations were found between the cranial base and hyoid bone measurements, suggesting a potential functional association.
- The weak negative correlation between the gonial angle and hyoid triangle area suggests limited impact of mandibular angulation on the hyoid bone position.

These results underscore the intricate relationships among the cranial base, mandible, and hyoid bone in Class II skeletal individuals.

DISCUSSION

This study evaluated the correlation between the cranial base, mandible, and hyoid bone in individuals with skeletal Class II malocclusion. The findings reveal significant interrelationships among these structures, offering insights into the etiology and treatment planning for such malocclusions.

The cranial base length and angle significantly influenced mandibular length, as evidenced by a strong positive correlation. This finding aligns with previous studies that reported cranial base morphology plays a pivotal role in mandibular development and anteroposterior positioning (1,2). A shortened cranial base or an increased cranial base angle has been associated with mandibular retrognathism, a hallmark of Class II skeletal malocclusion (3,4).

The moderate correlation between cranial base measurements and the hyoid bone position suggests that cranial base morphology indirectly affects airway-related structures. The hyoid bone, a key component of the airway and tongue posture, is functionally linked to mandibular growth and orientation (5,6). Similar findings have been reported in studies highlighting the interplay between the cranial base and the hyoid bone in maintaining pharyngeal airway stability (7,8).

The weak negative correlation observed between the gonial angle and hyoid triangle area suggests that mandibular angulation has a limited impact on hyoid bone positioning. This observation is consistent with studies that noted minimal influence of mandibular angles on hyoid bone dynamics (9,10). However, other studies have suggested that extreme variations in gonial angle may affect hyoid bone position and airway function, warranting further investigation (11,12).

Several researchers have highlighted the importance of the hyoid bone in evaluating craniofacial and functional abnormalities (13). The hyoid bone's anatomical position is influenced by mandibular morphology, and its displacement in Class II individuals may contribute to compromised airway function (14). This study corroborates these findings by identifying moderate correlations between hyoid bone measurements and cranial base-mandibular parameters.

The variations in findings across studies could be attributed to differences in sample characteristics, methodologies, and cephalometric landmarks used. Standardized methods, as employed in this study, are crucial for ensuring reliable and reproducible results (15,16).

This study is limited by its relatively small sample size and cross-sectional design. Longitudinal studies with larger cohorts are needed to establish causal relationships between these anatomical structures. Moreover, three-dimensional imaging techniques, such as cone-beam computed tomography (CBCT), could provide more detailed insights into the spatial relationships among these structures.

CONCLUSION

The correlations observed in this study emphasize the need to consider cranial base and hyoid bone morphology during diagnosis and treatment planning for Class II skeletal malocclusions. Functional appliances that modify mandibular growth may also influence the hyoid bone's position and airway dynamics, underscoring the importance of a multidisciplinary approach.

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