Effect of Tongue Position on Facial Morphology of Pakistani Adults and Different Growth Patterns

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ABSTRACT

Objective: To determine the effect of tongue position on facial morphology of Pakistani adults and different growth patterns.

Study Design: Cross-sectional study.

Place and Duration of the Study: Department of Orthodontics, Karachi Medical and Dental College, Karachi, Pakistan, from January to April 2021.

Methodology: The study included individuals aged 17 to 30 years with no history of prior orthodontic treatment, absence of wound, burn, or scar tissue in the neck region, comfortable breathing through the nose, absence of deglutition disorder, and a skeletal Class I or II relationship. The exclusion criteria were a cleft lip or palate, or a history of chronic mouth breathing, snoring, or tonsillectomy. According to their skeletal relationships, the subjects were split into three groups; Group I (low-angle), Group II (normal growth), and Group III (high-angle). Vertical growth pattern was assessed on radiograph by interpreting the values of NS / ML (nasion-sella / mandibular plane) angle, and angle formed between FH / ML (Frankfort horizontal plane / mandibular plane). A predesigned proforma was used to record all the measurements made on pre-treatment lateral cephalograms by the sole investigator. Data were analysed using SPSS 24.0.

Results: Data from the lateral cephalogram of 79 patients, consisting of 18 (22.8%) males and 61 (77.2%) females who met the inclusion criteria, were analysed. The sample included 15 low-angle, 45 normal vertical growth, and 19 high-angle cases. Fifty participants had Class I skeletal relationships, while 29 had Class II relationships. According to the ANOVA test, FH / ML and NS / ML measurements showed no statistically significant variations in tongue position and growth trends.

Conclusion: There was no statistically significant difference between tongue position and facial morphology of Class I or II subjects with different vertical growth patterns. However, there was a statistically sufficient evidence showing the tongue height was greater in Class I skeletal relationship patients as compared to Class II skeletal cases (p = 0.008).

Key Words: *Tongue position, Tongue space, Tongue length, Growth pattern.*

How to cite this article: Ghafoor HA, Hussain SS. Effect of Tongue Position on Facial Morphology of Pakistani Adults and Different Growth Patterns. *J Coll Physicians Surg Pak* 2024; **34(08)**:927-931.

INTRODUCTION

The tongue is the largest organ in the oral cavity and the body's most flexible and agile appendage. Its function is crucial, and its growth, posture, and function are important considerations.[1,2] Tongue position and volume play a vital role in influencing morphological characteristics and dentofacial biomechanics.[3] Various studies suggest that tongue volume affects the facial vertical dimension, chin location, and symphysis.[3-5]

Other studies suggest that resting pressures from the tongue, lips, and cheeks are decisive in determining teeth position.[5] The tongue has long been known to contribute to the placement of dento-alveolar structures.[6]

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Received: October 29, 2022; Revised: July 01, 2024; Accepted: July 09, 2024
DOI: https://doi.org/10.29271/jcpsp.2024.08.927

Alterations in the surrounding dento-alveolar anatomy and skeleton may result from abnormalities in either function or location. As the body of the mandible lengthens, the attachments of the genioglossus and geniohyoid muscles move forward, increasing the pharyngeal space. This relationship between tongue length and its position in relation to the pharyngeal wall in skeletal Class II and Class III seems logical.[1] Skeletal malocclusion may be caused, in part, by abnormalities in posture or function. To determine whether the position truly alters skeletal morphology, it must be analysed in various sagittal patterns.[7-9] Class II malocclusions, in Balter's view, develop when the tongue is in an abnormally retroflexed posture, causing issues in the cervical region. Therefore, the assessment of the tongue is crucial in orthodontic diagnosis and treatment planning for functional, positional, and structural considerations.[1]

Dento-alveolar development, maxillary and mandibular growth, tongue and lip function, and tooth eruption are the potential causes of vertical malocclusion in developing children. One major concern with tooth extraction treatment is the dramatic reduction of available tongue space.[10,11] Some physicians believe that closing extraction gaps may cause the maxilla and mandible to retrude, narrowing the oro-pharyngeal airway.[10-14]

The purpose of this research was to examine how tongue position correlates with adult face morphology and growth trends in Pakistan. A literature search revealed a lack of local data on this topic, and international values may not be applicable to the Pakistani population due to genetic and anatomical differences. The study's results will provide insights into the effect of tongue position on craniofacial morphology, potentially aiding in identifying relationships for improved management and better results in the future.

METHODOLOGY

This research was carried out with the approval of the Ethical Review Board of the Karachi Medical and Dental College (KMDC). After receiving approval from the institution's Ethics Committee, the researcher examined records from 79 patients who met the study's inclusion criteria and had made visits to the Orthodontics clinic, KMDC, between January and April 2021. Verbal informed consent was taken from the patients. The World Health Organization's calculator for determining sample sizes was used. The inclusion criteria for this study comprised adult patients, aged 17-30 years, with no history of prior orthodontic treatment, absence of wound, burn, or scar tissue in the neck region, comfortable breathing through the nose, absence of deglutition disorder, and a skeletal Class I or II relationship. Participants meeting these criteria were excluded in the study if they had a cleft lip or palate, or a history of chronic mouth breathing, snoring, or tonsillectomy.

Anatomic tracings and dento-skeletal landmarks were manually conducted by a single investigator. The craniofacial analysis involved several measurements to assess various angles and dimensions.

The set of measurements conducted in this study encompassed various anatomical parameters related to craniofacial and oral structures. Firstly, the SNA angle was determined, representing the angle formed by the convergence of lines drawn through Point S (mid-point on the Sella-turcica), Point N (most anterior point on the fronto-nasal suture in the mid-sagittal plane), and Point A (most concave point on the anterior maxilla). Subsequently, the SNB angle was measured, defined as the angle formed by the convergence of lines through points S, N, and B (most concave point on the anterior mandible). The ANB angle, calculated by subtracting the SNB angle from the SNA angle, provided insights into the relationship between the anterior maxilla and mandible.

Additionally, two measurements focused on tongue morphology were undertaken. Tongue length (TGL) was quantified as the linear distance between the base of the epiglottis (Eb) and the tongue tip (TT), measured along the line connecting Eb and TT. Tongue height (TGH) was determined as the linear distance along the perpendicular bisector of the Eb-TT line to the dorsum of the tongue. Lastly, tongue space, expressed in square millimetres, denoted the area formed by the superior and posterior borders of the tongue, along with specific points T, Me, H1, and H2. These comprehensive measurements aimed to provide a thorough understanding of craniofacial and tongue characteristics within the scope of the study.

Eb (base of the epiglottis): The lowermost point of the epiglottis.

TT (tongue tip): The most anterior point of the outline of the tongue.

H1 (intersection between the posterior border of the tongue and the hyoid bone): The point where posterior border of the tongue intersects with the hyoid bone.

H2 (the most anterior point of hyoid bone): The foremost point of the hyoid bone.

T (the most anterior point of the outline of tongue): The frontmost point of the tongue.

Me (menton - the inferior point of the symphysis): The lowest point on the midline of the mandibular symphysis.

NS: Nasion to Sella turcica.

ML: Mandibular plane (gonion to menton).

FH: Frankfort horizontal plane (porion to orbitale).

These measurements were conducted to provide a comprehensive analysis of craniofacial features and tongue characteristics among the study participants.

Cephalometric radiographs were taken using a standardised technique on 79 participants. Subjects were divided into three categories based on their growth pattern: Group I, low-angle; Group II, normal growth; and Group III, high-angle. All measurements were performed on pretreatment lateral cephalograms by a single investigator. The sample included 15 low-angle, 45 normal vertical growth, and 19 high-angle cases, 50 subjects had a Class I skeletal relationship (normal ANB $2 \pm 2°$, SNA mean value is $80 \pm 2°$, and SNB mean value is $78 \pm 2°$) and 29 had a Class II relationship. Vertical growth pattern was assessed on radiograph by interpreting the values of the angle formed between NSL and ML, and angle formed between FH and ML (NSL / ML normal-angle if the value is $30 \pm 4°$, and $25 \pm 4°$ for FH / ML). It was said to be a low-angle case if the value was less than $30 \pm 4°$ for NSL / ML, and less than $25 \pm 4°$ for FH / ML and said to be high-angle if the value was greater than $30 \pm 4°$ for NSL / ML and greater than $25 \pm 4°$ for FH/ML.

SPSS 24.0 was used to analyse the data. Age, low-angle, normal-angle, high-angle, TGL, TGH, and tongue space were measured. Mean and standard deviation were computed for each variable. Effect modifiers such as age and gender were addressed through stratification, post-stratification. The ANOVA test was performed. A p-value <0.05 was taken as significant.

RESULTS

Out of the 79 cases that met the inclusion and exclusion criteria, 18 (22.8%) cases were males and 61 (77.2%) were females. The average age of the patients was 20.35 ± 2.402 years. Out of 18 males, 6 with low facial angle, 9 with normal growth pattern, and 3 with high facial angle. Out of 61 females, 9 with low facial angle, 36 with normal growth pattern, and 16 with high facial angle (Table I). In the sample, there were 15 low-angle, 45 normal-vertical-growth, and 19 high-angle. Class I skeletal relationship was found in 50 cases and 29 had a Class II skeletal relationship (Table I).

Low-angle cases had a mean TGL of 75.53, a mean TGH of 30.07, and a mean tongue spacing of 27.26. High-angle cases have a mean TGL of 73.16, a mean TGH of 32.21, and a mean tongue spacing of 28.03 (Table II). Using One-way ANOVA, the result showed that the p-values were not statistically significantly different for all the three dependent variables (TGL p-value 0.176, TGH p-value 0.158, and tongue space p-value 0.249).

According to the ANOVA test, NS / ML ratio showed no statistically significant difference between dependent variables (TGL p-value 0.086, TGH p-value 0.150, and tongue space p-value 0.158) as p-values are >0.05. The difference of tongue lengths between skeletal Class I and II did not reach to statistically significant results (p = 0.453). The TGH was more in Class I patients (mean = 32.82 ± 3.243) as compared to skeletal Class II patients (mean = 30.31 ± 4.965) reaching statistically significance (p = 0.008). The difference of tongue space between skeletal Class I and II did not reach statistically significant results (p-0.711). The finding of the present study found that there was no significant correlation established between the tongue position and facial morphology of Class I or II skeletal patients with different growth patterns, but TGH showed statistically significant results in Class I patients (Table III).

DISCUSSION

The purpose of this study was to evaluate the impact of tongue position on facial morphology and various skeletal patterns. The forces exerted by the tongue play an important role in the guidance of tooth eruption, dental arch form, and stability.[1,12] Mandible and hyoid bone are where the tongue is primarily attached.[15] The positioning of the dentoalveolar structures by the role of the tongue has long been established.[16,17] Changes in the dentoalveolar structure and skeleton can result from abnormal tongue function or location.[1] Subjects with normal antero-posterior skeletal patterns and normal nasal breathing were included in this study. The reasons for excluding patients with cleft lip and palate was to rule out any syndrome which might affect the skeletal anteroposterior dimensions.[1]

One study suggested that patients in the skeletal Class II group had lower tongue posture, and the tongue body was smaller than that of those in the Class I group. The tongue length and H-Me in the skeletal Class I group with a low-angle were significantly larger than those with an average angle and high-angle.[18] Lateral Cephalometric radiographs have been used to investigate the intramural airway spaces, tongue, soft palate, and supporting structures, such as the hyoid bone, mandible, and cervical vertebrae.[19,20]

Gender and age had no impact on tongue size in Class I or Class II topics. These findings agree with those reported in the previous literature,[21-24] which suggest that gender differences have no role on the tongue dimensions. In the previous study, it was found that Class III subjects' tongues were observed to be noticeably longer than Class II individuals' tongues, however, in this study, TGH was higher in Class I patients as compared to Class II patients and there was no statistically significant effect of TGL on facial morphology and growth patterns.[21] Tongue space and tongue gap were larger in high-angle subjects than in low-angle subjects.[7]

Table I: Gender and age of subjects by vertical growth pattern.

Vertical growth pattern	Sample size	Gender		Age	
		Male	Female	Mean	SD
Low-angle	15	6	9	21.07	2.172
Normal-angle	45	9	36	20.44	2.331
High-angle	19	3	16	19.58	2.219
Total	79	18	61	20.35	2.402

Table II: Mean and standard deviation of TGL, TGH, and tongue space in normal, low, and high-angle cases.

Vertical growth pattern	Tongue length (p = 0.176)*		Tongue height (p = 0.158)*		Tongue space (p = 0.249)*	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Low facial angle	75.53	5.263	30.07	5.713	27.2667	2.963
Normal facial Angle	75.60	4.525	32.30	3.537	29.145	4.076
High facial angle	73.16	5.408	32.21	3.735	28.036	4.526

** NS= Not significant.*

Table III: Mean and standard deviation of tongue length, height and tongue space in skeletal Class I and Class II cases.

Skeletal class	Tongue length (p = 0.453)*		Tongue height (p = 0.008)		Tongue space (p = 0.711)*	
	Mean	SD	Mean	SD	Mean	SD
I	75.32	4.821	32.82	3.243	28.39	4.345
II	74.45	5.166	30.31	4.965	28.74	3.489

**NS= Not significant.*

There is a scarcity of local-level studies on this topic, and international publications addressing this subject have not been particularly recent.

CONCLUSION

According to the study's findings, Class I or Class II skeletal patients with various growth patterns, TGH, tongue space, and facial morphology were not significantly positively correlated. There was a statistically significant evidence showing TGH is more in Class I skeletal relationship patients as compared to Class II skeletal cases.

ETHICAL APPROVAL:
This study was carried out after receiving approval from the Ethical and Scientific Review Committee of the Karachi Medical and Dental College, Karachi, Pakistan (Reference No. 0043/2021).

PATIENTS' CONSENT:
Written informed consent was obtained from patients who participated in this study.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
HAG: Conception and design of the study, acquisition of the data, analysis, and interpretation.
SSH: Supervision of the project, critical revision of the manuscript, conception, and design of the study.
Both authors approved the final version of the manuscript to be published.

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