Original Research Paper

Volume - 10 | Issue - 6 | June - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Dental Science

RELATIONSHIP OF MANDIBULAR MORPHOLOGY, TONGUE POSITION, AIRWAY AND HYOID BONE IN CLASS III MALOCCLUSION

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ABSTRACT

Objective: The aim of the study was to investigate the relationship of mandibular morphology and various uvulo-glossopharyngeal structures in class III malocclusion.

Materials and Methods: The study used lateral Cephalograms of 25 subjects exhibiting skeletal Class III pattern. All Lateral Cephalograms were traced by a single operator and statistically analyzed.

Results: The results revealed a positive correlation between Tongue length, MAS, VAL, HRGN, C3H, RH, and mandibular length ($p<0.05$). TGH has a Positive correlation with VAL, RH and ML. SPAS has positive correlation with MAS, IAS, HRGN, C3H, RH, and ML. MAS has positive correlation with IAS, MH, HRGN, C3H, RH, ML. IAS has positive correlation with HRGN, C3H, RH, and ML. VAL has positive correlation with MPH, and ML

Conclusion: The uvuloglosso-pharyngeal structures: Tongue Position, Airway, Hyoid Bone and mandibular morphology show a significant correlation with each other suggesting to have a contributory factor in causing a certain type of skeletal pattern.

KEYWORDS : Class III Malocclusion, Mandibular Morphology, Tongue Position, Airway, Hyoid Bone.

INTRODUCTION

Growth of the jaws is influenced either by genetic and/or environmental factors. Currently, it is accepted that genes and its products help regulate craniofacial morphogenesis. However, these gene products do not determine growth and specific form, but they rather provide factors that may affect the receptivity and responsiveness of cells to intrinsic and extrinsic stimuli. Therefore, it appears that a range of physiologic, pathologic, and mechanical factors can influence growth. Although it has been shown that a close form and function relationship exists, the degree of interplay is still a matter of discussion. In order to assess any environmental effects on the development of Class III skeletal malocclusion the knowledge of its association with given environmental factors, i.e. tongue posture would be useful.[1]

The position of the hyoid bone relative to the cranial base and the mandible has been of interest specifically as an indicator of tongue posture and function.[2] The hyoid bone, supported by its muscular and ligamentous attachments, has broader physiologic ramifications as it provides a functional interface between mandibular, laryngeal and cranial structures and the vital passageways these structures define. The belief that hyoid posture may be correlated with mandibular morphology and position has led to a consideration of various skeletal types[3,4,5,6]. The several studies in this area have disparate results with some authors positively correlating hyoid position to skeletal type. Surgical retrusion of mandible for correction of mandibular Prognathism also results in changes in hyoid position.[7,8,9] Therefore, the aim of this study was to investigate the relationship of mandibular morphology and various uvulo-glossopharyngeal structures in a class III malocclusion

MATERIALS AND METHODS

The pre-treatment lateral Cephalograms of 25 subjects exhibiting skeletal Class III pattern were selected from the Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth dental college and Hospital, Pune.

Inclusion Criteria:

- ANB less than 0^0.
- Age over 15 years.

Exclusion Criteria:

- History of orthodontic treatment.
- Presence of any wound or burn scar in the neck region.
- Any craniofacial deformity / syndrome.

All Lateral Cephalograms were traced by a single operator. The cephalometric landmarks and lines[10] used in the study are as follows:

ANS *- Tip of the anterior nasal spine*

Point B *- Most posterior point on the concavity along the anterior surface of the symphysis*

Go *- The most convex point along the inferior border of the ramus*
TT *- Tongue tip*
Eb *- Base of epiglottis*
C3 *- Antero-inferior limit of the third cervical vertebra*

Rgn *-* ***Retrognathion*** *The most posterior point of symphysis*

H - **Hyoidale** *The most superior and anterior points on the body of the hyoid bone*

Ar - Articulare *the point of intersection between the posterior border of the mandibular ramus and the inferior border of the posterior cranial base*

Me - Menton *the inferior midline point on mandibular symphysis*

Go-B *A line joining Go and point B*

MPH**:** perpendicular distance from hyoid to mandibular plane

H-RGN *distance between hyoid bone and RGN*

HH1*: perpendicular distance from hyoid bone to line connecting C3 and RGN*

Cephalometric points were registered yielding 10 linear measurements and 1 angular measurement (Figure 1) which are as follows:
Tongue: *TGL*- tongue length (Eb-TT), *TGH*- tongue height (maximum height of tongue along the perpendicular line of Eb-TT line to tongue dorsum).

Airway: *SPAS*: superior posterior airway space (width of airway behind soft palate along parallel line to Go-B line), *MAS*: middle airway space (width of the airway along a parallel line to the Go–B line through inferior tip of soft palate), *IAS*: inferior airway space (width of the airway space along the Go–B line), *VAL*: vertical airway length (the distance between PNS and Eb).

HYOID: *MPH*: perpendicular distance from hyoid to mandibular plane, *HH1*: perpendicular distance from hyoid bone to line connecting C3 and RGN, *HRGN*: distance between hyoid bone and retrognathion (RGN), *C3H*: distance between hyoid bone and C3.

MANDIBULAR MORPHOLGY: *RH*: Ramal Height (Ar-Go), *ML:* Mandibular length (Go-Me), *GA*: Gonial angle. All measurements were carried out by the same author. Statistical analysis was carried out using Pearson's correlation coefficient test to detect relationship between the variables. A P-value of less than 0.05 was considered statistically significant.

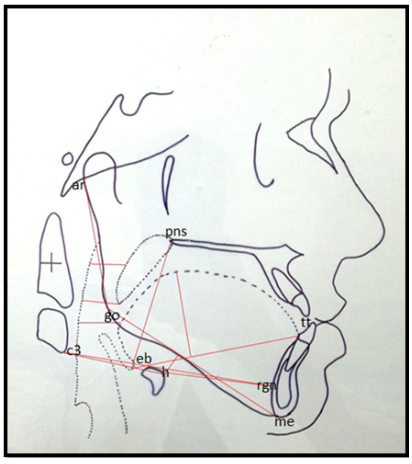

Figure 1. Cephalometric points, lines, and linear variables used in the cephalometric analysis. TT, tongue tip; Eb, base of epiglottis; PNS, posterior nasal spine; Me, menton; Go, gonion; RGN, retrognathion; H, hyoidale; C3: Anteroinferior limit of third cervical vertebra. Mandibular plane: Go-Me; Ar:articulare.

RESULTS

The observations of the study and the results derived are shown in Table 1 & Table 2.

I. Relationship of Tongue*:* The Tongue length shows a positive and highly significant correlation with mandibular length and C3H. A Positive and significant association is seen with Middle Airway Space, Vertical Airway length, HRGN, Ramal Height and vice versa.

The Tongue height shows a positive and highly significant relation with vertical airway length and a positive significant relation with ramal height and mandibular length. The tongue dimensions have a positive correlation with most of other parameters but are not significant.

II. Relationship of Airway: The superior airway space (SPAS) shows a positive and highly significant relationship with middle and inferior airway space (IAS). It also shows a significant relationship with HRGN, C3H, Ramal height and mandibular length.

The middle airway space shows a positive and highly significant relation with inferior airway space and a positive significant relation with MPH, HH1, HRGN, C3H, Ramal height and mandibular length.

The Inferior airway space (IAS) shows a positive and significant relation with HRGN, C3H and mandibular length.

The vertical airway length shows positively significant relation with MPH and mandibular length. The Airway dimensions have a positive correlation with most of other parameters but are not significant.

III. Relationship of Hyoid: The Hyoidale-Retrognathion (HRGN) shows a positive and significant association with mandibular length, Ramal height and vice versa. The distance between C3 and Hyoidale (C3H) also showed a positive correlation with ramal height and mandibular length.

IV. Relationship of Mandibular morphology: the Ramal height and mandibular length showed a positive and highly significant relationship with each other. They also show a positive and significant relation with tongue length, tongue height, superior airway space.

No significant correlation of Gonial angle (GA) was seen with other parameters.

The graphs depicting the correlation between various Parameters are shown in Figure 2,3,4,5,6,&7.

Table 1: Showing correlation of tongue and airway with other parameters.

	TGL	TGH	SPAS	MAS	IAS	VAL	MPH	HH1	HRGN	C3H	RH	ML	GA
TGL- Pearsons correlation		0.380	0.346	0.404	0.372	0.617	0.062	0.128	0.586	0.688	0.588	0.706	-0.13
Sig (2-Tailed)		0.079	0.091	0.045*	0.067	0.001*	0.0767	0.543	0.002*	0.000**	0.002*	0.000**	0.532
N		25	25	25	25	25	25	25	25	25	25	25	25
TGH- Pearsons correlation			-0.069	-0.19	0.012	0.741	0.209	0.082	0.055	0.192	0.447	0.573	0.131
Sig (2-Tailed)			0.0745	0.349	0.953	0.000	0.317	0.696	0.795	0.359	0.025	0.003	0.533
N			25	25	25	25	25	25	25	25	25	25	25
SPAS-Pearsons correlation				0.836	0.758	-0.13	-0.241	-0.29	0.472	0.504	0.467	0.552	-0.09
Sig (2-Tailed)				0.000	0.000	0.523	0.247	0.154	0.017	0.010	0.018	0.004	0.653
N				25	25	25	25	25	25	25	25	25	25
MAS- Pearsons correlation					0.838	-0.17	-0.463	-0.31	0.510	0.449	0.402	0.407	-0.18
Sig (2-Tailed)					0.000	0.393	0.020	0.129	0.009	0.024	0.046	0.044	0.385
N					25	25	25	25	25	25	25	25	25
IAS- Pearsons correlation						-0.010	-0.236	-0.381	0.624	0.556	0.373	0.409	0.172
Sig (2-Tailed)						0.625	0.257	0.061	0.001	0.004	0.066	0.042	0.410
N						25	25	25	25	25	25	25	25
VAL- Pearsons correlation							0.418	0.350	0.122	0.289	0.329	0.472	0.074
Sig (2-Tailed)							0.038	0.086	0.562	0.161	0.108	0.017	0.725
N							25	25	25	25	25	25	25

p>0.05- not significant ***p<0.05- significant** ****p<0.001-highly significantA**

Table 2 : Showing correlation of Hyoid and mandible with other parameters

	HH1	HRGN	C3H	RH	ML	GA
MPH-Pearsons correlation	0.600	0.082	0.220	-0.086	0.081	0.371
Sig (2-Tailed)	0.002	0.698	0.290	0.62	0.701	0.068
N	25	25	25	25	25	25
HH1-Pearsons correlation		- 0.04	0.059	0.086	0.106	-0.05
Sig (2-Tailed)		0.823	0.78	0.682	0.614	0.78
N		25	25	25	25	25
HRGN-Pearsons correlation			0.693	0.431	0.483	0.091
Sig (2-Tailed)			0.000	0.031	0.014	0.066
N			25	25	25	25
C3H-Pearsons correlation				0.609	0.700	-0.058
Sig (2-Tailed)				0.001	0.000	0.81
N				25	25	25

RH- Pearsons correlation Sig (2-Tailed) N					0.810 0.000 25	-0.152 0.469 25
ML- Pearsons correlation Sig (2-Tailed) N						-0.104 0.606 25
GA- Pearsons correlation Sig (2-Tailed) N						

p>0.05- not significant *p<0.05- significant **p<0.001-highly significant

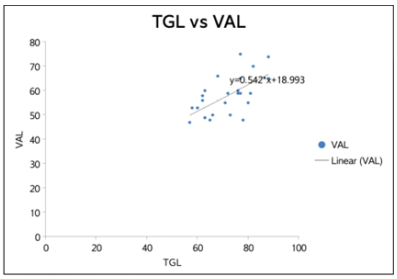

Figure 2. Graph depicting correlation between TGL and VAL.

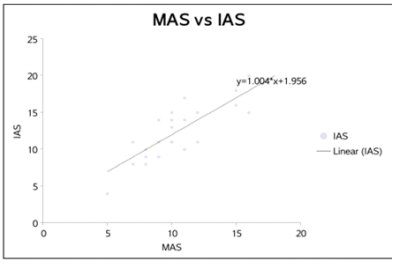

Figure 3. Graph depicting correlation between MAS and IAS

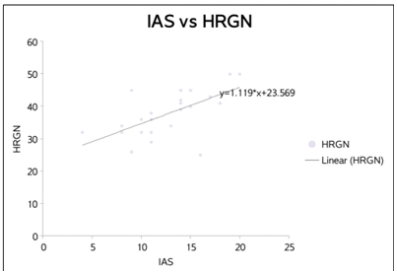

Figure 4. Graph depicting correlation between IAS and HRGN.

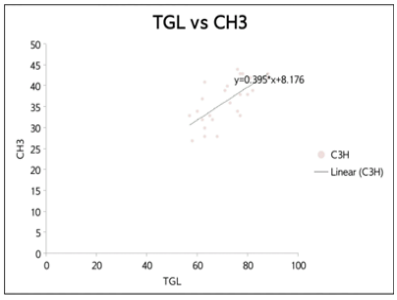

Figure 5. Graph depicting correlation between TGL and Ch3.

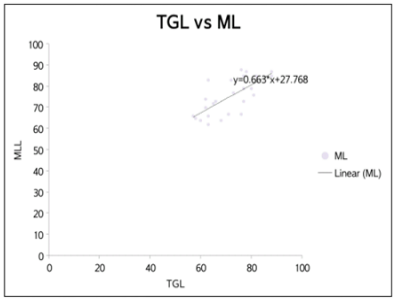

Figure 6. Graph depicting correlation between TGL and ML.

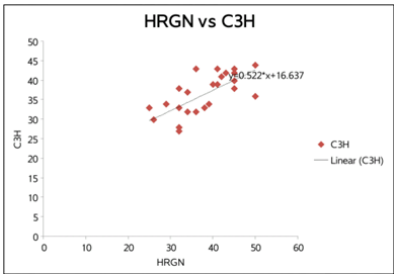

Figure 7. Graph depicting correlation between TGL and ML.

DISCUSSION

The influence of the soft tissues on growth and development is well known. It not only plays an important role in etiology of malocclusion but also on treatment planning. The different sagittal skeletal patterns may be a contributory factor in variation position of tongue and hyoid bone. As the hyoid bone is very important element for the function of both the suprahyoid and infra hyoid groups of muscles, its role in contributing to a specific orientation and function of these muscles might be instrumental in the establishment of specific structural elements of the jaws and the occlusion of the teeth. The nasopharyngeal dimensions continue to grow rapidly until 13 years of age[11] and then slow down until adulthood[12,13]. In this study the inclusion criteria for age was above 15 years to ensure oropharyngeal structures have reached an adult size.

This investigation revealed a positive and significant correlation between various structures in a Class III malocclusion. As the tongue length increases the mandibular length is increased, which as has an effect on the airway space. The tongue length and height, airway space and position of hyoid bone are all inter-related with each other. Change in dimension or position of one can affect the other, hence playing an important role in causing certain malocclusions. Various studies[14,15,16] have investigated the relationship between uvulo-Glossophayngeal dimensions in various skeletal patterns, and have concluded that in a class III skeletal pattern, tongue length is significantly longer. Also the superior pharyngeal airway space, middle and inferior airway space were found to be larger in class III pattern. In our study similar results were found as the tongue length had a significant positive correlation with the mandibular length and the airway space. The increase in one increases the other and vice versa. Iwasaki et al [17] used CBCT and compared and concluded that class III was associated with larger airway space.

In our study the airway space shows a significant positive correlation with HRGN, C3H, Ramal Height, and Mandibular Length. This was similar to the results obtained by Graber[18], Issa[19], Yemaoka[20] et al, who studied the position of the hyoid bone and relation of airway and mandibular length and concluded mandibular advancement is associated with an increase in oropharyngeal dimension and subsequent hyoid bone displacement that improves the airway's permeability. Turnbull and Battagel[21] also demonstrated a significant decrease in the retrolingual airway dimension after mandibular advancement surgery.

In our study a significant association was seen in hyoid bone position and mandibular length suggesting changes in the position of one will affect the other. These findings can be supported by findings in the literature by Marsan et al[22] who studied the changes in hyoid bone position in Class III patients after mandibular setback surgery and concluded that Surgical correction of mandibular prognathism altered the position of the hyoid bone by downward repositioning carrying the root of the tongue downwards immediately postoperatively, but followed with a tendency to return to its original position.

In our study mandibular morphology showed a significant correlation with the airway which is in agreement with the findings by Dunn and Green et al who studied the relation of mandibular morphology and nasopharyngeal airway size in monozygotic twins and concluded that airway size is related to mandibular morphology.

CONCLUSION

The present study has shown that:

- The uvuloglosso-pharyngeal structures: Tongue Position, Airway, Hyoid Bone and mandibular morphology have a significant correlation with each other suggesting to have a contributory factor in a Class III skeletal pattern.
- The relationship between various structures in oro-facial region has to be kept in mind before framing any treatment plan to prevent relapse and achieve stable results.

Limitations of the Study

The use of the lateral cephalometric radiographs to evaluate the upper airway is somewhat limited as they provide only 2-dimensional images of the nasopharynx, which consists of complex 3-dimensional anatomical structures. Therefore, Future investigations using 3-dimensional imaging will be beneficial.

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