Postural and Dimensional Changes in the Tongue from Rest Position to Occlusion

LEONARD S. FISHMAN, D.D.S.

INTRODUCTION

Tongue posture and function are of interest in regard to their relationship to malocclusion and speech defects. Abnormalities of either posture or function could possibly contribute to the development of malocclusion and speech problems. It is possible that malocclusion and speech defects could be the causes of abnormal posture and function of the tongue.

One of the general objectives of this study will be to ascertain if differences exist between individuals with normal occlusions and those with abnormalities in tooth position. Differences will also be investigated between individuals with a speech defect and those without. The majority of the time the tongue is at rest position and for this reason postural and dimensional changes in the tongue were investigated from physiologic rest position to occlusion.

MATERIAL AND METHODS

Three series of lateral cephalometric roentgenograms were used for the purposes of this study. A normal group consisted of twenty-nine children and adults who had no obvious speech defects or detrimental habits, and who possessed a generally acceptable soft tissue profile. The second or malocclusion group of twenty-seven children consisted of nineteen Class II, Div. 1 cases, five Class I cases, two pseudo Class III cases, and one Class II, Div. 2 case. All of these patients were to undergo orthodontic treatment. The third or speech group consisted of twenty-seven children who underwent speech evaluations and were categorized as lispers. Both rest and occlusion radiographs were traced. To facilitate tracing of the tongue, a thin coating of tantalum powder mixed with gum acacia and water was painted on the median sulcus and tip of the dorsum on the majority of the patients.

A coordinate system was devised using as reference planes the palatal plane and a line dropped perpendicular to the palatal plane (Ptm plane) from the most inferior point of the pterygomaxillary fissure. Both of these planes are easily superimposed when comparing the occlusal radiograph to the rest radiograph. As illustrated in Figure 1, five points were constructed on the dorsal surface of each traced tongue:

Point A- tip of tongue

Point H- highest point on dorsum

Point AH- point on dorsal surface of tongue constructed by drawing a line between Points A and H. The line is then bisected.

Point P- posterior point on dorsum of tongue constructed by drawing a line from point A parallel with the palatal plane

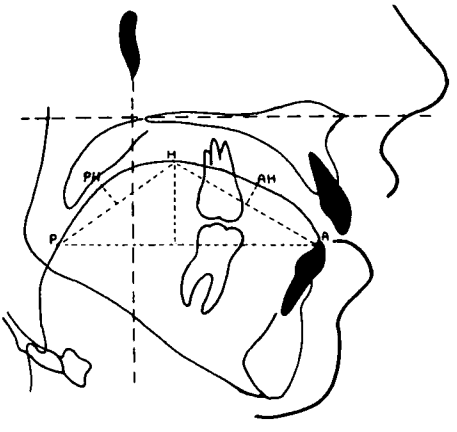

Fig. 1

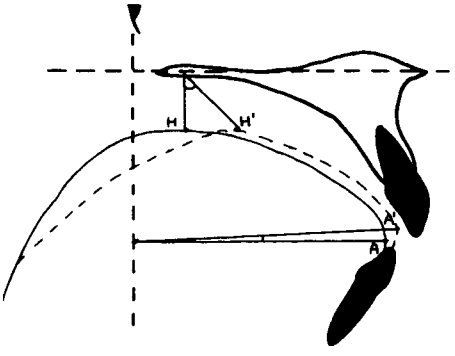

Fig. 2

Point PH- point on dorsal surface of tongue constructed from line H-P in the same manner as point A-H.

Changes in the above points from rest position to occlusion were angularly measured from both the palatal and Ptm planes recording the data in separate horizontal and vertical components (Fig. 2). The vertical and horizontal changes were always measured by making sure the original (rest) and final (occlusion) points were the same vertical level when measuring horizontal change, and the same horizontal level when measuring vertical change. Such horizontal and vertical angular measurements were recorded for the five designated points on the eighty-three selected cases. So that the data could be more easily analyzed, the separate horizontal and vertical components were reduced to one numerical value that represented both. This was accomplished by first plotting the separate horizontal and vertical values as shown in Figure 3, and then by placing a 360 degree protractor on the point of intersecting coordinates. By establishing the horizontal anterior line as zero degrees, each plotted point was then measured on the protractor. Anterosuperior dimensional change was therefore presented as 0-89 degrees, posterosuperior direction as 91-179 degrees, posteroinferior direction as 181-269 degrees, and the anteroinferior direction as 271-359 degrees. The directional changes for each group were then graphed.

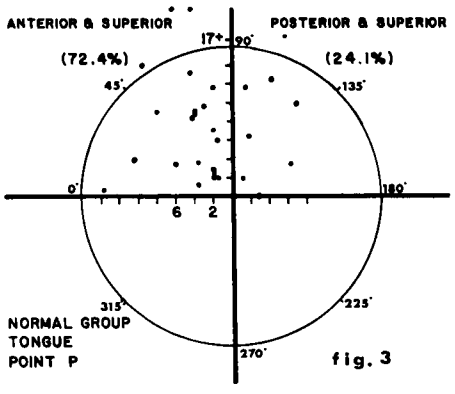

Fig. 3 Example of method used to plot angular and linear changes for each point.

Numerical values representing the relative distances that the points moved were derived basically in the same manner as described above. The only difference was that instead of the angle being measured, the linear distance was measured in millimeters from each plotted point to the point of intersecting coordinates. Thus, a single numerical value was established for each individual movement, one that represented both the horizontal and vertical relative distances for each point. These values were graphed for each group.

Although it has been shown how the directional movements of the various surface areas of the tongue are derived, it was necessary to see if the points on the tongue that moved in specific directions a considerable percentage of time in each group actually moved together in these directions for each individual patient. Therefore, the directional movements for each patient were charted. Beside the five dorsal points already mentioned, movement of the lower incisor from rest to occlusion was also charted for each patient.

The percentages of increase or decrease in the length and height of the tongue were also noted in the same

	Point A			point AH			point H			point PH			point P		
	N	M	S	N	M	S	N	M	S	N	M	S	N	M	S
SUPERIOR				6.9	7.4					6.9					
ANT—INF					11.1		10.3	11.1		17.2					
POST—INF				13.8	18.4	18.5	13.8	11.1	11.1		14.7	14.7		14.7	18.4
POSTERIOR				10.3				11.1							
INFERIOR										10.3					
ANT—SUP	42.4	33.3	14.7	41.4	28.1	29.8	41.4	37.0	40.7	41.4	55.5	51.8	72.4	62.9	59.3
POST-SUP	55.2	44.4	62.9	20.7	28.8	44.4	20.7	22.2	29.6	10.3	11.1	11.1	24.1	11.1	18.4
ANTERIOR											11.1				

TABLE I

manner. The percentage increase or decrease in tongue length was determined by comparing the length of lines A-P on the rest and occlusion radiographs.

The percentage increase or decrease in tongue height was determined by comparing the lengths of the perpendicular lines dropped from point H to A-P on the rest and occlusion radiographs. Thus, correlations between the movements of the various dorsal points, the directional movement of the mandible as represented by the tip of the lower incisor, and the percentage changes in length and height were made.

The relationship of the tip of the tongue and its approximation or nonapproximation to the teeth and alveolar tissue was noted. The approximation or nonapproximation of the tongue to the soft palate was also noted. Linear measurements were taken from the highest point on the dorsum to the level of the hard palate, and from the highest point of the tongue to the maxillary occlusal plane. These measurements were done for all radiographs.

Findings

Some definite consistencies in the patterns of tongue movement occurred within each group and between the groups studied. As seen in Table I, the posterior portion of the dorsum moved anterosuperiorly from rest to occlusion in the majority of cases. It is interesting to note that this pattern of movement progressively increased in percentage of occurrence the more posterior the dorsal location.

In the majority of cases the patients in all three groups moved the tip of the tongue posterosuperiorly, rather than anterosuperiorly. This was especially true in the speech group. The dorsal area just posterior to the tip of the tongue continued the posterosuperior tendency only in the speech group.

There was a definite general increase in the distances the specified points moved as observed from the anterior to the posterior portion of the tongue with the exception of point P. In other words, the posterior aspect of the tongue seemed to move more than the anterior. There was an impressive similarity between the magnitude ranges of

GROUP	P ↖ PH	P ↗ PH	P ↖ PH H AH	P ↖ PH H AH?	PH ↖ H	AH ↖ H	AH ↗ H ↖	A ↖ AH	A ↖ AH ↗
NORMAL	44.8	37.9	24.1	—	34.4	34.4	—	24.1	—
MALOCCLUSION	55.5	37.0	25.9	7.4	37.0	25.9	7.4	18.4	3.7
SPEECH	48.1	33.3	22.2	7.4	37.0	29.6	11.1	11.1	3.7

	A ↗ AH	A ↗ AH ↖	A ↖ P	A ↗ P ↖	A ↖ H	A ↗ H ↖	A ↖ T	A ↗ T
NORMAL	13.7	13.7	34.4	41.3	17.2	24.1	50.0	36.3
MALOCCLUSION	22.2	11.1	29.6	31.0	22.2	18.4	100.0	50.0
SPEECH	33.3	11.1	7.4	48.1	11.1	29.6	100.0	40.0

TABLE II

the respective points when comparing the three groups, although the average magnitude values were consistently larger in the Class I malocclusion cases.

As seen in Table II, there were some very strong correlations of directional movement of the specified points to each other when observing the individual cases per se. The posterior points of the dorsum, P and PH, were closely correlated in both their anterosuperior and posterosuperior directional movements. The high point of the tongue and the dorsal areas just anterior and posterior to it were not as well correlated. There were strong correlations between the directional movement of the tongue tip and the anterosuperior movement of the posterior of the tongue, whether the movement of the tongue tip be in an anterosuperior or posterosuperior direction. There is in the normal group little correlation between the direction of mandibular movement and directional movement of the tongue tip. For the other two groups there is little correlation in the posterosuperior direction, but excellent correlation in the anterosuperior direction.

In all three groups the tongue usually decreased in its length. In the normal and malocclusion groups the tongue usually decreased in height; but, in the speech group, the tongue increased in height in almost as many cases as it decreased. The decrease in height occurred usually even though the high-point of the tongue moved superiorly from rest position to occlusion, and when the posterior of the tongue moved anteriorly and the tongue tip moved posteriorly. Therefore, the tongue most probably decreased in volume from rest to closure as measured in this study.

Eight basic postural tongue tip positions were seen in all three groups for both positions. In the rest position the speech and normal group tongue tips usually were contacting the lingual surface of the lower incisor. No predominant postural tongue tip position existed in the malocclusion group at the rest position. In the occlusal position the postural relationship where the tongue tip contacted the lingual surface of the lower incisor was usually observed for all three groups. In the normal and malocclusion groups the position where the tongue tip contacted both the upper and lower anterior teeth was also commonly seen. There was no general tendency for the tongue tip to elevate itself into a more superior postural position as the mandible moved superiorly from rest to closure.

In both rest and occlusion, for all three groups, the level of the dorsum of the tongue was always superior to the maxillary occlusal plane, but hardly ever contacted the hard palate. From rest position to occlusion the distance

between the tongue and hard palate decreased an average of three millimeters in the speech group and one millimeter in the other two groups. The posterior dorsal surface of the tongue usually contacted the oral surface of the soft palate in the normal and malocclusion groups at rest position, but did not usually touch in the speech group. In dental occlusion the two surfaces usually contacted for all three groups. In those cases where the tongue and soft palate did not contact, this dimension between the two surfaces was greatest in the speech group. This dimension usually decreased from rest to closure.

Discussion

Normal tongue posture and movement from rest position to occlusion can be described. In general, the tip of the tongue contacted the lingual surfaces of the lower incisors in both rest position and occlusion. In both rest and occlusion positions the dorsum of the tongue was superior to the occlusal plane, but usually did not contact the hard palate. The posterior area of the dorsum contacted the soft palate.

When the mandible moved from rest position to occlusion in the normal individuals, the posterior area of the tongue moved upwards and backwards. The posterior area of the dorsum traveled a greater distance within the oral cavity. From rest position to occlusion, the tongue in the normal group usually decreased in relative length and height.

Abnormalities in tongue posture and dimensional change from rest position to occlusion did seem to be associated with the abnormal functional problem of lisping. Anterior tongue movement was more posteriorly directed for the speech group. Tongue posture for the posterior aspect of the tongue was more anteriorly related for the speech group when compared with normals. In the speech group the tongue increased in height from rest position to occlusion. This was associated with the tendency toward posterior movement of the anterior area of the tongue and the more forward posture of the posterior area of the tongue.

The malocclusion group demonstrated no predominant tongue-tip posture. This may indicate the tongue in these individuals adapted to structural environmental differences. The fact that Class I malocclusions demonstrated more dimensional change than the other forms of malocclusion may also indicate that the structural environment plays an important role in tongue activity.

Summary

Postural and dimensional relationships of the tongue in rest position and occlusion have been evaluated using an angular cephalometric analysis that demonstrated changes in direction and dimension. Similarities and differences between normal, speech and malocclusion groups have demonstrated that form and function have some direct relationships to abnormal tongue posture and movement.

It is felt that this information can be of value in the continued investigation of swallowing patterns, speech production and the role of the tongue in the development and retention of the occlusion.

600 East Genesee Street
Syracuse, New York 13202

ACKNOWLEDGMENT

The author wishes to thank Dr. J. Daniel Subtelny, Director of the Orthodontic Department, Eastman Dental Center, for his assistance in the preparation of this manuscript.