

**A STUDY OF THE POSTURE OF THE TONGUE  
IN INDIVIDUALS WITH NORMAL OCCLUSION**

**By**

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## INTRODUCTION

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The tongue in both man and animal has been considered through the ages to be a complex organ. It is a highly specialized combination of muscles and nerves and contains one of the five senses, the sense of taste. As H. B. Walter and L. P. Sayles stated in their book entitled: "Biology of the Vertebrates," "The tongue serves many purposes. It is capable of great freedom of movement; it is a universal toothbrush, serves as a curry comb for fur-bearers, while animals like cats and dogs that lap up liquids use it as a spoon, it stands ready to receive the password of admittance from entering food, and in humans is essential for speech, respiration and swallowing."

Even though the tongue is a complex organ, in its actions and structure, it is unlike most organs of the human body. Man has not concerned himself to a great extent over its history of development for many reasons. It is encased by the orbicularis oris complex and buccinator muscles and teeth, thereby making ease of observation of its actions and development difficult. Another factor which acts against its observation is its apparent constant mobility.

Most postulations previously set forth concerning the action of the normal tongue have been unsupported by scientific data. Studies have been reported on abnormalities of the tongue and its associated surroundings, but little or no research on the normal tongue posture has been reported.

Recently roentgenography has been used to study areas of the body not easily seen by the naked eye. In the infancy of roentgenography development, it was considered by several investigators that this would be an important means of studying the tongue and thus this study came into being.

## REVIEW OF THE LITERATURE

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It has long been an accepted fact that the tongue plays an important role in mastication, speech, respiration and arch development. Much has been written about the action and posture of the tongue as it affects the eruption of teeth and their positions in the dental arches. Most of the postulations previously made by investigators are unsupported by scientific research. Although universal acknowledgement is made of the power of the tongue to misshape the dental arches, little concerted study has been devoted to determine whether the tongue is an important factor in forming the arches originally.<sup>1</sup>

The tongue develops from the ventral ends of the branchial arches. It has two sources of origin. An oral and pharyngeal origin. The oral portion comprises most of the body and occupies the definitive mouth cavity. It arises from the mandibular arches in front of the oral membrane and hence is covered with ectodermal epithelium. This part bears papillae and is concerned with mastication. The pharyngeal portion is the root. In embryos of four weeks (5 millimeters) the body of the tongue is indicated by three primordia.<sup>2</sup> These are the paired lateral swellings of the first branchial arches, which latter have fused as the mandible and the median, somewhat triangular tuberculum impar wedged in between them. At the same time, the future root is represented by a median elevation, brought into existence by the union of the bases of the second branchial arches and for this reason named the copula (a yoke). Between the tuberculum impar and the copula is the point of origin of the hyoid diverticulum. This site becomes secondarily depressed into a prominent pit which occupies the apex of the terminal sulcus and constitutes the permanent landmark known as the foramen caecum.<sup>3</sup>

The individual components of the tongue are in the process of fusion during the sixth week. The lateral swellings of the first arches increase rapidly in size, unite with the tuberculum impar, and nearly enclose it. In sharp contrast, the two lateral swellings are indicated superficially by the median sulcus and internally by the fibrous, median septum. The copula, together with the adjacent portions of the second branchial arches, enlarges greatly to produce the early root of the tongue. Eventually, however, this territory seems not only to be encroached upon by the third and fourth branchial arches, but there is a slipping forward of their mucous membrane as well.

Continued expansion of the tongue both in length and breadth brings into existence a deep,  $\Lambda$ -shaped furrow at the front and sides which will make the organ partly free and highly mobile. At the same time (seventh week) the tongue elevates and assumes prominence through the differentiation of striated muscles internally. This musculature is innervated by the hypoglossal nerve caudad of the branchial arches. Except for slight inclination suggestive of migration, the muscles of the tongue appear to arise in situ from mesenchyme of the arches that make up the floor of the mouth.

There have been very few actual reports on the development of the tongue through childhood to adulthood. At birth, according to Brodie, the jaws are wide apart, although the lips are closed, the tongue completely fills the mouth and protrudes over the alveolar ridges supporting the lips.<sup>4</sup> The frenum of the tongue normally short and tight at infancy, has been considered abnormal by many practitioners and subjected to frenectomy, but this shortness is normal and the baby's tongue should not be subjected to frenectomy.<sup>5</sup> During the growth of the jaws from three to six months, the jaws are held apart by the tongue and over a growth period

of eight years with the eruption of teeth, growth of alveolar process and development of the tongue, the jaws are no longer apart but in contact through the occlusion of the teeth. During this portion of its growth, the tongue is relatively larger than the jaws, or closer to its proportions in the adult. The tongue is gradually enclosed, not by the shutting together of the jaws, but by the growth of the alveolar processes together with eruption of the teeth. Such growths apparently compensate to a large degree for vertical dimension establishment.

The anterior-posterior increase in length of the mandible unlike the increase in vertical dimensions of the maxilla and mandible is achieved by rapid accretion on the posterior of the ramus of the mandible and absorption at the anterior border. There is endochondral growth at the condyle until at least the twentieth year, it provides the forward and downward direction for mandibular growth and contributes also to increased width of the jaws. In addition to early over-all growth, the growth in length and height of the mandible takes place principally at the condylar portion of the mandible, which is gradually replaced by bone, while growth in length of the body of the mandible and width of the ramus takes place mainly by apposition.

Some facts about the tongue are generally accepted; it is a highly muscular part capable of radically changing its shape within short intervals of time; its movements are accomplished with great speed, and it plays an important role in mastication, swallowing, dental arch development and maintenance and in respiration and speech. In the past, most of the investigations relative to the tongue have been related to tongue position in cleft palate patients, perverted functions such as infantile swallowing, tongue thrusting, abnormal pressures and congenital defects.

The tongue is composed of extrinsic and intrinsic muscles. The

extrinsic muscles are the genioglossus, hyoglossus, chondroglossus, styloglossus and glossopalatinus. The intrinsic muscles are the longitudinalis superior, longitudinalis inferior, transversus and verticalis. The muscles of the tongue are attached at the symphysis of the mandible, body of the hyoid bone and greater cornu also the styloid process.

There are four nerves in each half of the tongue. The lingual branch of the trigeminal which is distributed to the papillae at the fore part and sides of the tongue; the lingual branch of the glosso-pharyngeal, which is distributed to the mucous membrane at the base and side of the tongue and to the papillae circumvallate; the hypoglossal nerve, which is distributed to the muscular substance of the tongue; and the chorda tympani, which is composed of special sensory (taste) and parasympathetic fibers to the lingual surfaces of the tongue. Sympathetic filaments also pass to the tongue from the superior cervical ganglion carrying special visceral afferent fibers with the carotid artery to the tongue. The glosso-pharyngeal and superficial petrosal nerves are the chief nerves of the sense of taste, the lingual is the nerve of common sensation and the hypoglossal is the motor nerve of the tongue.

The movements of the tongue, although numerous and complicated, may be understood by carefully considering the direction of the fibers of its muscles. The genioglossi, by means of their posterior fibers, draw the tongue forward and protrude the apex from the mouth. The anterior fibers of the genioglossi retract the tongue into the mouth. The two muscles acting in their entirety draw the tongue downward so as to make its superior surface concave from side to side, forming a channel along which fluid may pass toward the pharynx, as in sucking. The hyoglossus depresses the tongue and draws down its sides. The styloglossus draws the tongue upward and backward. The glossopalatina retracts the root of the tongue, whereby it becomes shortened, narrowed, or curved in different directions; thus, the longitudinalis superior and inferior tend to shorten the tongue,

but the former, in addition, turns the tip and sides upward so as to render the dorsum convex. The transversus narrows and elongates the tongue and the verticalis flattens and broadens it. The direction in which they run give to this organ the power of assuming the forms necessary for the enunciation of the different consonantal sounds. <sup>7</sup>

From the foregoing description of the tongue musculature, it can be seen that it is a complicated structure. Defects in any of the muscles or in their innervation will result in changes in posture of the tongue as seen in partial paralysis of the hypoglossal nerve, glosoplegia, bulbar paralysis and ankyloglossia as well as hypermobility. <sup>8</sup>

Many factors govern the posture of the tongue and have been discussed and postulated since the early nineteenth century. The musculature suspending the tongue governs to a large extent the posture the tongue assumes. Brodie has stated, "The tongue is gradually enclosed, not by the shutting together of the jaws, but by the growth of the alveolar process (downward in the upper and upward in the lower), together with eruption of the teeth." <sup>9</sup>

Numerous investigators have reported the tongue maintains a normal position for an existing type occlusion and the tongue, when at rest, occupies a large part of the oral cavity. <sup>10, 11, 12, 13</sup> They have also reported that its tip is lowered and rests against the oral surfaces of the lower incisors, whereas, the dorsum is elevated. In class two malocclusions, the tongue dorsum is higher in all respects, but more uniformly so than in class one occlusions, class three malocclusions are usually associated with a tongue which is lower at the apex and progressively elevated in the mouth as it extends into the oropharynx to lie in contact with the soft palate. <sup>14</sup> In normal human occlusal relationship or neutro-occlusion, the maxillary permanent first mesio-buccal cusp must occlude in the buccal groove of the mandibular permanent first molar and the mesio-lingual cusp of the maxillary first permanent molar must occlude in the central fossa of the mandibular permanent first molar. Deviations

in any manner of this cuspal relationship will result in malocclusion  
and thus the classification of malocclusions came into being. <sup>15</sup>

It has also been stated by Baker that, "The height of the position of  
the normal tongue is controlled by the vault of the maxilla and there is  
a possibility that in a normal mouth, normal tongue position contributes  
to normal development of the maxilla." <sup>16</sup>

With the use of slow motion pictures, a study was made of the tongue  
and its relation to denture stability. <sup>17</sup> This same study set forth the  
theories that some normal tongue positions were low and some high. It  
was noted that with the tongue in the low level position, the lateral  
borders rest against the lingual surfaces of the lower occlusal surfaces  
of the mandibular posterior teeth and in many instances the tongue carried  
the imprint of the lingual surfaces of the maxillary posterior teeth.

McKee has stated, "In sixty-five percent of patients with average  
dentitions for their particular age groups, the tongue was completely  
lax in the floor of the mouth with the apex slightly below the incisal  
edges of the mandibular incisors and the dorsum of the tongue visible  
above the teeth in all parts of the mouth." <sup>18</sup>

Many investigators are of the opinion that the dorsum of the tongue  
at rest is in contact with the soft palate and velum. The reasoning  
behind this theory is thought to be due to negative pressure in the roof  
of the mouth and that this vacuum pulled the soft palate down into con-  
tact with the dorsum of the tongue.

The literature reveals that McKee, <sup>19</sup> Russell, <sup>20</sup> Thompson, <sup>21</sup> Kelly  
<sup>22</sup> and Higley were investigators who attempted to obtain a quantitative  
method of studying this highly mobile organ in a habitat unseen with the  
lips closed.

Russell and Thompson designed an experiment in which they positioned a patient in a Broadbent Cephalometer arrangement and placed a small gold link chain on the sulcus of the tongue. A cephalometric lateral roentgenograph was taken and a tracing made. A fallacy in his technique was the known presence of the chain on the tongue causing the muscle to react to this slight amount of weight giving inaccurate results.<sup>23</sup>

Kelly and Higley used a sticky mixture of two parts barium sulfate to one part gum acacia incorporated in a commercial mouthwash to give radiopaqueness to the soft tissues of the mouth. The mixture was applied to the dorsum of the tongue and hard palate with a cotton applicator and the patient was instructed to swallow and then lick their lips. No further instructions were given. Sufficient time was given to allow the patient to become accustomed to the solution then the roentgenographs were taken. Two lateral cephalometric roentgenographs were taken in rest position and occlusion.<sup>24</sup>

McKee used a radiopaque iodochloral material which he made into a thick and thin mixture. The thick mixture was painted on the dorsum of the tongue and palate. The thin mixture was drawn into a syringe of the Luer type and the material introduced into the left nostril. This fluid gave more definition to the floor of the nose, naso-pharynx and soft palate. A lead plate was used externally to focus and intensify the rays of a dental roentgenographic machine.<sup>25</sup> A cephalometric roentgenographic technique described by Broadbent was used.<sup>26</sup>

Buck used the cephalometric technique described by Broadbent to study tongue volume in a group of children with cleft palates. A lead plate was incorporated to obtain good definition of the soft tissues. Barium sulfate and twenty percent gum acacia was painted on the mid-line of the tongue,

the mid-line of the velum and hard palate, and the mid-line of the posterior pharyngeal wall covering the area of Passavant's pad.

Investigation has extended beyond the predeciduous developmental phase, deciduous dentition phase and permanent dentition phase to the edentulous phase. As a seemingly final step toward understanding the posture of the tongue, Sir Wilfred Fish<sup>28</sup> reported experimental evidence in which he demonstrated the tongue space of an edentulous patient. Through this experiment, one can surmise that though the tongue be first unrestricted in predeciduous stage except by the orbicularis musculature, then restricted by full complements of teeth and return to unrestriction, it remains unduanted and occupies the oral cavity in a most possessive manner. The result of this experiment adds support to the belief that the tongue volume and space cannot be encroached upon if the tongue is to function normally and unrestricted.

Individuals with a natural dentition are unable to carry out normal function if the apex of the tongue is removed; likewise, chewing is impossible on the side of the mouth which the buccinator muscle has been denervated. It has been surmised, therefore, that defects in muscular<sup>29</sup> development would hamper the normal function of the tongue.

Many investigators have postulated that the constant abnormal thrusting of the tongue may result in separation of the anterior teeth<sup>30, 31, 32, 33, 34 and 35.</sup> particularly the maxillary central incisors.

Klein has stated that macroglossia or continued forcing of the tongue against the lingual surfaces of the upper and lower anterior teeth results in spacing, and he also made the statement as a result of observa-<sup>36</sup> tion, that a large tongue may cause an over-development of the mandible.

Oral habits cause variation in tongue posture. Some oral habits associated with changes in tongue posture are tongue sucking or improper swallowing habits which are associated with severe open-bite and increased overjet production. Forcing the tongue against the lingual surfaces of the upper and lower anterior teeth result in spacing of the anterior teeth. <sup>37,38,39.</sup> Finger sucking, mouth breathing, and nail biting also result in a change in tongue posture in that the tongue is positioned higher and further forward than is normally found. <sup>40,41,42</sup>

A tongue of essentially normal size and in harmony with its surroundings exerts a pressure on the surrounding oral structures. These pressures have been measured by Kydd and established as 8.05 pounds per square inch, in comparison to 4.4 pounds per square inch exerted by the lips. <sup>43</sup> This pressure exerted by the tongue is of an intermittent type, but has a definite affect on the position of the teeth. Tisdale, Teuscher and Rogers have also reported studies which show the result of abnormal tongue pressures and the resultant malocclusions. If their research needed corroboration, the study by Kydd would certainly help justify the claim that pressures by the tongue can result in malocclusions if unopposed by the lip musculature.

Highly abnormal form and diminutive size of the mandibular arch found associated with congenital aglossia provide proof of the vital importance of normal tongue form and function to normal occlusion. <sup>44</sup>

Most investigators who have made a study of the abnormal pressures of the tongue are in accord that open-bites are a result of these abnormal forces. Sheppard <sup>45</sup> has summed up the abnormal pressures of the tongue in the following manner:

1. Forward movement of the tongue:
  - a. nonocclusion of the anterior teeth with crowding and rotation.
  - b. nonocclusion of the anterior teeth and some posterior teeth with crowding and rotation.
2. Forward and upward pressure:
  - a. slight enlargement of the upper jaw with spacing of the upper anteriors.
3. Forward and downward pressure:
  - a. enlargement of the lower jaw, cross-bite of some or all teeth and spacing of lower anterior teeth.
  - b. associated destruction of gingival tissue and bone.
4. Lateral force:
  - a. nonocclusion in bicuspid region of one or both sides occurring with occlusal contact present elsewhere.

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Schwartz used dogs in an experiment to determine the effects of the tongue on tooth movement. He designed a method of applying to the teeth a constant light force of a magnitude comparable to that exerted by the tongue. He used a small gentle continuous spring force of 3-5 grams or 0.110 pounds. In this experiment, he showed a definite movement of the dogs' teeth with such a force. It is recognized that experiments carried out on laboratory animals cannot be completely applied to human reactions in similar conditions.

**STATEMENT OF THE PROBLEM**

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The present study was undertaken in an effort to gain additional information relative to the position of the tongue when the mandible is at rest and when the teeth are in centric occlusion. An attempt has been made to determine if there is a basic technique which can be employed to consistently measure and record normal tongue posture. If a technique can be established to determine normal tongue posture, additional studies can be undertaken to include abnormal tongue positions.

However in this study, the research will be limited to the establishment of the normal posture of the tongue if there is one, and if not, to disprove the theory that there is one.

## MATERIALS AND METHODS

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Twenty-two Caucasian children who had clinically good occlusions were selected for this study. The sample consisted of fifteen males and seven females. Their ages ranged from seven years eight months to sixteen years. The sample was small because we failed to see numerous clinically good occlusions.

Definite criteria were set so the variables would be minimized as much as possible in the results obtained. Requirements were eight permanent anterior teeth erupted and in occlusion; and four permanent first molars erupted and in occlusion.

Materials used were: commercial micropaque material (a barium sulfate compound), tap water, tongue blade, sterile cotton tipped swabs, paper cups, 2 x 2 gauze squares, and a Broadbent cephalometer unit (Fig. 1). The technique used was <sup>a</sup>modification of the combined techniques of Buck and Higley.

A thick paste of barium sulfate and water was prepared by adding 2cc of water to a preweighed amount of micropaque material (5 grams) and applied to the dorsum of the patient's tongue, apex and lingual frenum. (Fig. 2).

A Broadbent Cephalometer technique was employed to position the patient's head and aid in standardization of the technique. After positioning the patient in the cephalometer, the micropaque material was applied to the tongue and the patient instructed to swallow. Time was allowed for the patient to become accustomed to the material and when all visible throat and cheek movement had ceased, a roentgenograph was taken. The second roentgenograph was taken in the same manner as the first except the patient was instructed to bite the teeth together

**Fig. 1      Material employed in this study:**

**Graduated cylinder**

**Paper cup**

**2 x 2 gauze squares**

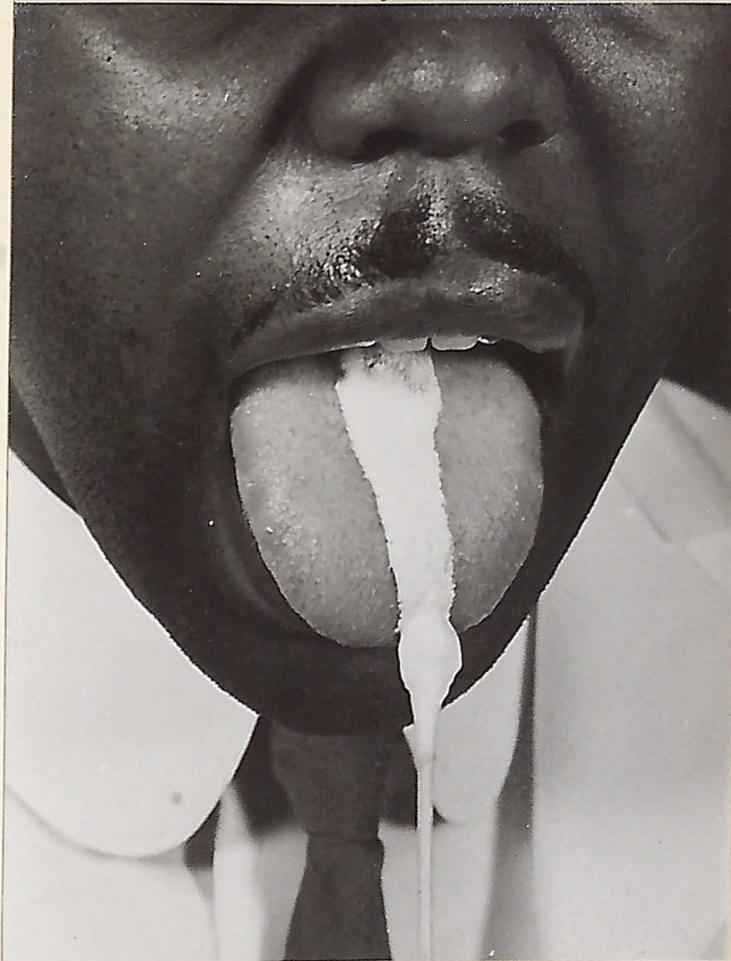
**Tongue blades**

**Cotton tipped swabs**

**Micropaque (barium sulfate compound)**



**Fig. 2. The application of micropaque to the patient's tongue.**



in the back and hold until the roentgenograph was taken. The third roentgenograph was taken as a check against the first for rest position of the mandible with the patient being instructed to relax and not to bite the teeth together.

To standardize the technique and insure rest position of the mandible and tongue, the two roentgenographs of the mandible in rest position were superimposed over a viewbox and tracings were made and superimposed. If measurements of the posture of the mandible or tongue varied more than 1.0 millimeter, subsequent roentgenographs were taken in rest position until satisfactory roentgenographs were obtained.

A sheet of acetate tracing paper was placed over the lateral head-plate roentgenograph and a detailed tracing made of the mandible in occlusion and one of the mandible at rest. The tracings were made in detail including all soft tissue of the oral cavity, teeth and cranial structures (Fig. 3 and 4).

Nine measurements were used to properly orientate and standardize the posture of the tongue. These measurements were established through cephalometric landmarks and skeletal landmarks (Fig. 5 and 6).

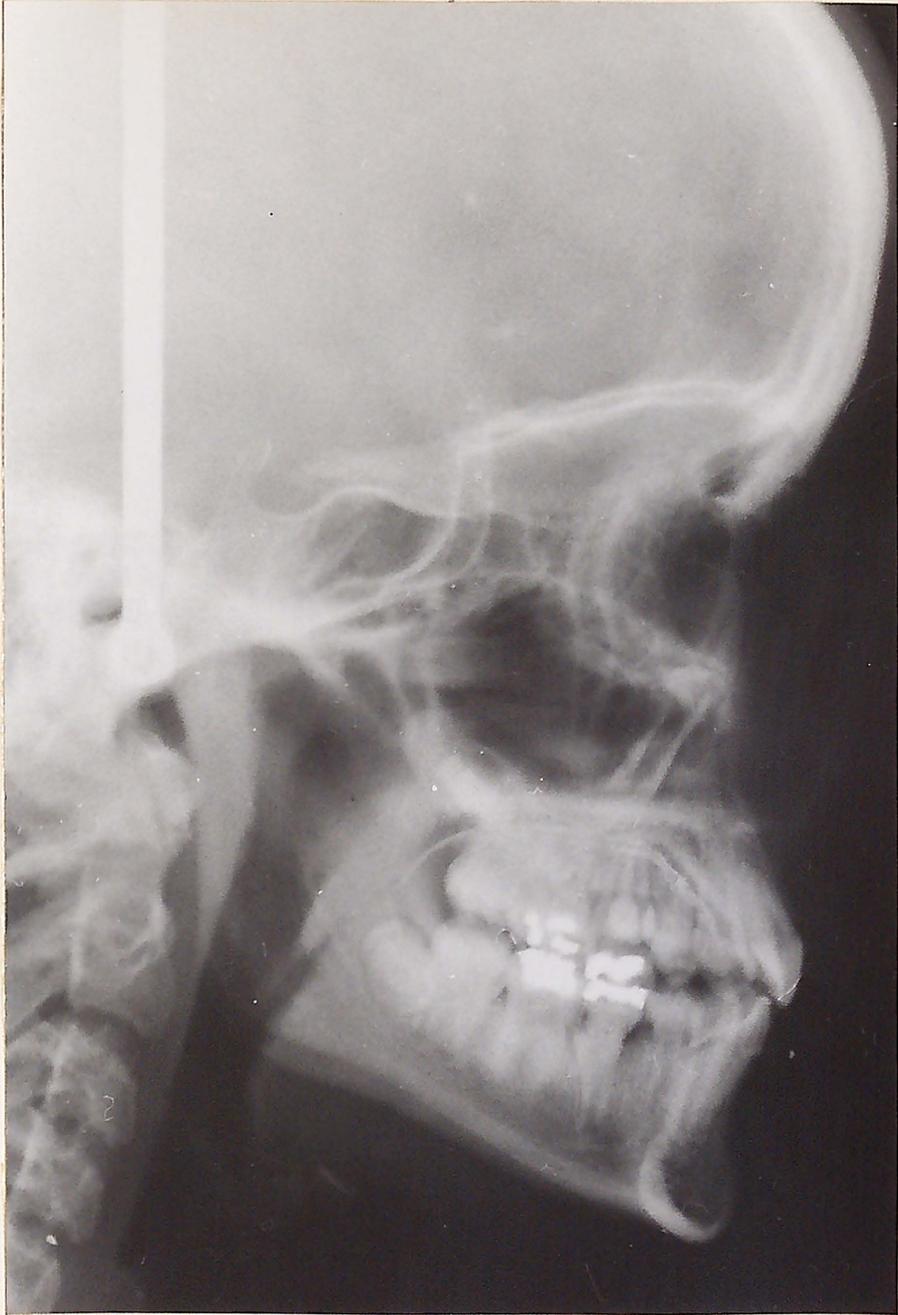
To obtain a thorough working knowledge of the position of the tongue, the measurements associated with the apex was considered first. The teeth and denture base or alveolar process, which is the bone supporting the teeth, are important to the amount of oral space and consequently govern tongue posture.

The palatal plane or nasal floor was selected as a base line or plane to aid in making consistent measurements. It was established by connecting anterior nasal spine (ANS) with posterior nasal spine (PNS).

**Fig. 3. Lateral cephalometric roentgenograph showing the mandible in centric occlusion.**

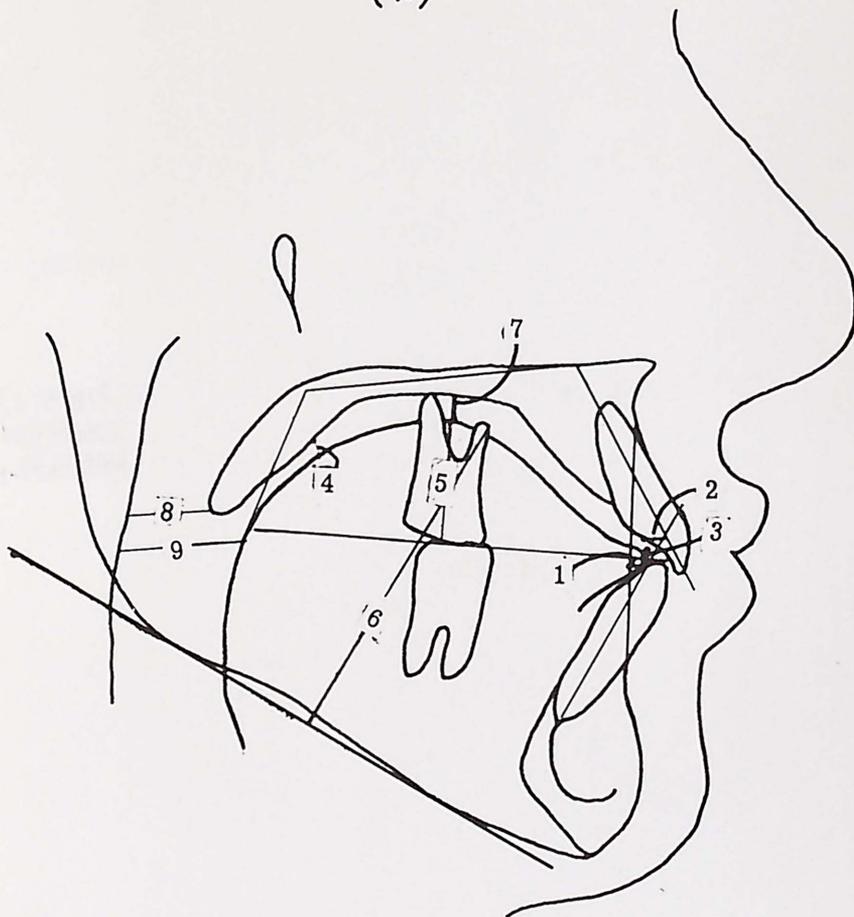


**Fig. 4.** Lateral cephalometric roentgenograph showing the mandible in rest position and the tongue in rest position.



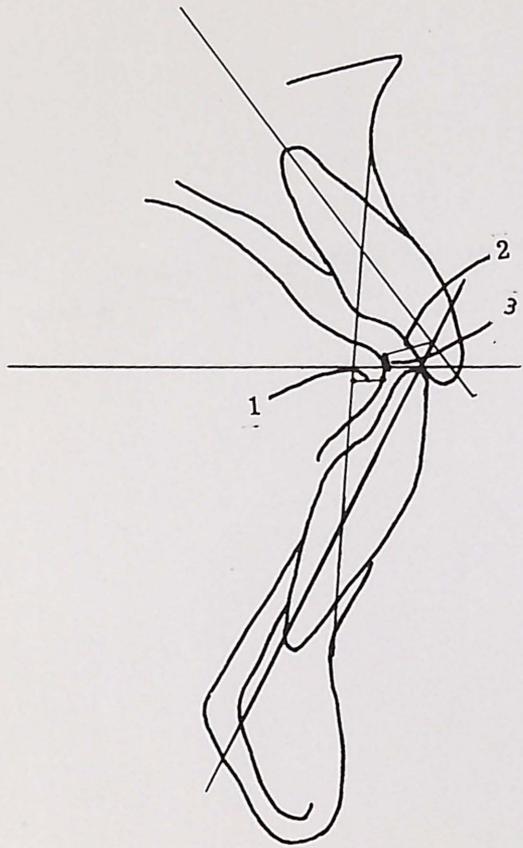
**Fig. 5. Diagram of acetate tracing made of lateral cephalometric roentgenograph showing numbered measurements.**

(1.)



**Fig. 6. Enlarged illustration of measurements  
of apex of the tongue.**

(1 a)



The first measurement was a horizontal measurement designed to determine the anterior-posterior relation of the apex of the tongue to the denture base. Subspinale (A) point and supramentale (B) point were connected by a straight line and was drawn parallel to nasal floor from the apex of the tongue to this plane.

The relationship of the tongue to the denture was determined by extending a line through the long axis of the most prominent maxillary and mandibular central incisors and where they intersected, a line parallel to nasal floor was extended to the apex of the tongue. This represented the second measurement.

With the establishment of measurements 1 and 2, the relative anterior-posterior position of the tongue was determined in relation to both the denture and denture base. Its vertical position in space was next determined by measuring the position of the apex of the tongue to the intersection point of A-B plane to occlusal plane. The vertical height of the apex of the tongue and third measurement, was established as a perpendicular line extended from the apex of the tongue to the occlusal plane in the region of the intersection of the A-B plane to it.

Measurements to determine the position of the dorsum of the tongue to hard and soft palate were next established. The first measurement to determine the height of the dorsum of the tongue was established by dropping a perpendicular line from the soft palate in the region of posterior nasal spine to the dorsum of the tongue and recorded as measurement number 4. Other vertical measurements of the tongue dorsum were made in a similar manner. A vertical measurement was made of the tongue dorsum to occlusal plane by erecting a perpendicular line from occlusal plane to the tongue dorsum at its highest point and a perpendicular was erected from mandibular plane to the dorsum of the tongue at its highest point. These were recorded as measurements 5 and 6 respectively. The last

measurement of the tongue dorsum was made by measuring a perpendicular line in the region of key ridge to the dorsum of the tongue and recorded as measurement number 7.

The last two measurements were designed to show the relative position of the tongue base to posterior pharyngeal wall and the position of the posterior tip of the soft palate to posterior pharyngeal wall. The posterior tip of the soft palate velum was connected to the posterior pharyngeal wall by a line drawn parallel to nasal floor. This measurement aided in the establishment of the anterior-posterior relation of the base of the tongue to the posterior pharyngeal wall. This was recorded as measurement number 8.

The last measurement was established by extending a tangent from posterior nasal spine to the base of the tongue and then at this intersection point, a line parallel to nasal floor was extended to posterior pharyngeal wall.

**PRESENTATION OF DATA**

TABLE I

Name	Age in Yrs.	Measurement (1)			Measurement (2)			Measurement (3)			Measurement (4)		
		Occ.	Rest	Diff.									
D.A.	8	1.0	1.0	0.0	5.0	5.0	0.0	2.5	3.0	0.5	13.0	17.0	4.0
W.B.	9	3.0	3.0	0.0	1.5	2.0	0.5	10.0	10.0	0.0	7.0	7.5	0.5
J.F.	13	1.0	1.0	0.0	3.0	4.0	1.0	2.0	3.0	1.0	20.0	20.0	0.0
D.F.	12	9.0	1.0	10.0	11.0	3.0	-8.0	2.0	3.0	1.0	14.0	4.0	-7.0
S.F.	11	2.0	0.0	-2.0	2.5	4.0	1.5	1.0	5.0	4.0	15.0	10.0	-5.0
L.H.	7-8	2.0	1.5	-0.5	1.0	3.0	2.0	3.0	1.0	-2.0	13.0	11.0	-2.0
J.H.	13	5.0	2.0	-3.0	2.0	5.0	3.0	3.0	5.0	2.0	13.0	19.0	6.0
L.H.	8	-0.5	1.5	-0.5	6.0	5.0	-1.0	2.0	2.0	0.0	9.0	16.0	7.0
J.L.	12	-3.0	0.5	3.5	3.5	2.0	-1.5	2.0	7.0	5.0	13.0	8.0	-5.0
D.M.	16	4.5	-3.0	-7.5	2.0	9.0	7.0	3.0	5.0	2.0	23.0	15.0	-8.0
P.M.	14	2.5	2.0	-0.5	3.0	7.0	4.0	1.0	5.0	4.0	22.0	14.0	-8.0
R.M.	9	3.0	3.0	0.0	2.0	3.5	1.5	2.0	7.0	5.0	18.0	13.0	-5.0
J.M.	10	0.5	2.0	1.5	4.0	4.0	0.0	7.0	5.0	-2.0	16.0	17.0	1.0
G.M.	11	-1.0	0.0	1.0	3.0	4.0	1.0	2.0	3.0	1.0	20.0	20.0	0.0
G.N.	13	2.0	1.0	-1.0	2.0	2.0	0.0	2.5	4.0	1.5	12.5	16.5	4.0
L.S.	8	0.0	1.0	1.0	5.0	5.0	0.0	2.0	1.0	-1.0	13.0	12.0	-1.0
G.S.	11	0.0	-3.0	-3.0	5.0	9.0	4.0	1.0	2.0	1.0	16.0	5.0	-11.0
J.T.	12	2.0	3.0	1.0	3.0	2.5	-0.5	2.5	3.0	0.5	24.0	23.5	-0.5
R.V.	10	4.0	3.0	-1.0	5.5	6.0	0.5	1.5	2.0	0.5	19.0	19.0	0.0
W.W.	9	-3.0	0.0	3.0	6.5	2.0	-4.5	2.0	1.0	-1.0	11.0	19.0	8.0
H.W.	12	2.5	5.0	2.5	0.5	0.0	-0.5	10.0	10.0	0.0	9.0	12.0	3.0
R.W.	12	1.5	0.0	-1.5	2.0	6.0	4.0	2.0	8.0	6.0	17.0	11.0	-6.0

TABLE I  
(Continued)

Measurement (5)			Measurement (6)			Measurement (7)			Measurement (8)			Measurement (9)		
Occ.	Rest	Diff.												
46.0	47.0	1.0	9.0	10.0	1.0	5.0	3.0	-2.0	3.0	2.0	-1.0	18.0	18.0	0.0
44.0	48.0	4.0	14.5	17.0	2.5	16.0	14.0	-2.0	2.0	4.0	2.0	15.0	12.0	-3.0
59.0	58.0	-1.0	6.0	4.0	-2.0	1.0	1.5	0.5	1.5	1.0	-0.5	12.0	10.0	-2.0
43.0	41.0	-2.0	15.0	18.0	3.0	5.0	11.0	6.0	-1.0	-2.0	-1.0	20.0	18.0	-2.0
46.0	42.0	-4.0	11.0	12.0	1.0	1.0	5.0	4.0	0.0	-0.5	-0.5	19.0	12.0	-7.0
45.0	39.0	-6.0	8.0	12.0	4.0	4.0	8.0	4.0	-0.5	1.0	1.5	15.0	18.5	3.5
52.5	55.5	3.0	13.5	11.0	-2.5	9.0	3.0	-6.0	0.0	5.0	5.0	20.0	17.0	-3.0
41.5	48.0	6.5	5.0	9.0	4.0	11.0	4.0	-7.0	-0.5	5.5	5.5	12.0	16.0	4.0
46.0	47.0	1.0	7.0	9.0	2.0	4.0	12.0	8.0	1.0	4.0	3.0	11.0	10.5	-0.5
59.0	58.0	-1.0	16.0	12.0	-4.0	1.0	12.0	11.0	1.0	3.0	2.0	19.0	12.0	-7.0
59.0	54.0	-5.0	14.0	13.0	-1.0	2.0	14.0	12.0	2.0	2.5	0.5	21.0	13.0	-8.0
50.0	50.0	0.0	16.0	18.0	2.0	2.0	7.5	5.5	2.0	5.0	3.0	23.5	16.0	-7.5
50.0	52.0	2.0	13.0	13.0	0.0	1.0	2.0	1.0	1.0	4.0	3.0	17.0	16.0	-1.0
45.0	50.0	5.0	15.0	13.0	-2.0	2.0	2.5	0.5	-1.0	0.0	1.0	15.0	15.0	0.0
50.0	54.5	4.5	10.0	10.0	0.0	5.0	1.0	-4.0	1.0	3.0	2.0	16.0	17.0	1.0
45.0	49.0	4.0	10.0	12.0	2.0	2.0	1.5	-0.5	0.0	1.0	1.0	19.0	18.0	-1.0
44.5	36.5	-8.0	7.0	15.0	8.0	1.0	15.0	14.0	5.0	-2.0	-7.0	21.5	15.0	-6.5
61.5	60.0	-1.5	13.0	15.0	2.0	3.0	4.0	1.0	5.0	4.0	-1.0	16.0	19.0	3.0
56.0	55.0	-1.0	8.0	11.0	3.0	1.0	1.0	0.0	4.0	3.0	-1.0	12.0	14.0	2.0
46.0	54.0	8.0	8.0	11.0	3.0	1.0	0.5	-0.5	4.0	4.0	0.5	14.0	13.0	-1.0
44.0	50.0	6.0	8.0	10.0	2.0	11.0	8.0	-3.0	0.0	2.0	2.0	15.0	13.0	-2.0
49.0	48.0	-1.0	12.0	9.5	-2.5	1.0	4.5	3.5	-0.5	-0.5	0.0	12.0	13.0	1.0

Measurement (1)

	Occlusion	Rest	Difference
Mean	0.93	1.02	0.09
Standard Deviation	3.027	0.157	2.393
Standard Error of Mean	0.661	0.034	0.522
Number "N"	22	22	22
"t" test			N. S.

Horizontal measurement of apex of the tongue from its apex to A-B plane.

Measurement (2)

	Occlusion	Rest	Difference
Mean	3.70	4.22	0.63
Standard Deviation	2.284	2.199	2.219
Standard Error of mean	0.498	0.480	0.484
Number "N"	22	22	22
"t" test			N. S.

Horizontal measurement of apex of tongue measured from intersection points of the long axis of most prominent maxillary and mandibular central incisor parallel to nasal floor to the apex of the tongue.

Measurement (3)

	Occlusion	Rest	Difference
Mean	1.11	2.22	1.11
Standard Deviation	1.481	1.581	1.959
Standard Error of Mean	0.355	0.345	0.427
Number "N"	22	22	22
"t" test			N.S.

Vertical measurement of apex of the tongue to occlusal plane.

Measurement (4)

	Occlusion	Rest	Difference
Mean	3.0	4.31	1.31
Standard Deviation	2.512	2.630	1.739
Standard Error of Mean	0.548	0.574	0.379
Number "N"	22	22	22
"t" test			N. S.

Vertical measurement of height of dorsum of tongue from soft palate in region of posterior nasal spine to tongue dorsum.

Measurement (5)

	Occlusion	Rest	Difference
Mean	15.16	14.02	1.14
Standard Deviation	4.419	4.698	3.167
Standard Error of Mean	0.964	1.025	0.691
Number "N"	22	22	22
"t" test			N. S.

Perpendicular measurement of height of tongue dorsum to occlusal plane.

Measurement (6)

	Occlusion	Rest	Difference
Mean	49.19	49.84	0.63
Standard Deviation	5.902	6.114	2.446
Standard Error of Mean	1.268	1.334	0.534
Number "N"	22	22	22
"t" test			N. S.

Perpendicular measurement of height of tongue dorsum to mandibular plane.

Measurement (7)

	Occlusion	Rest	Difference
Mean	4.04	6.13	2.09
Standard Deviation	4.039	4.738	3.917
Standard Error of Mean	0.881	1.034	0.854
Number "N"	22	22	22
"t" test			N. S.

Perpendicular measurement of dorsum of the tongue to the hard palate in the region of key ridge.

Measurement (8)

	Occlusion	Rest	Difference
Mean	10.86	12.02	1.16
Standard Deviation	3.391	3.171	1.622
Standard Error of Mean	0.740	0.692	0.354
Number "N"	22	22	22
"t" test			N. S.

Anterior-posterior measurement of the soft palate velum to posterior pharyngeal wall measured parallel to nasal floor.

Measurement (9)

	Occlusion	Rest	Difference
Mean	16.50	14.80	1.68
Standard Deviation	3.483	2.652	2.387
Standard Error of Mean	0.760	0.579	0.521
Number "N"	22	22	22
"t" test			N. S.

Anterior-posterior measurement of tongue base to posterior pharyngeal wall.

Anterior-posterior measurement of tongue base to posterior pharyngeal wall.

## DISCUSSION

## DISCUSSION

Since a study of the tongue is a difficult problem, few have been reported. Several reports found in the literature were of some value in an attempt to establish a technique for studying the tongue.

Twenty-two caucasian children were involved in this study. When the roentgenographs and acetate tracings were completed, the nine measurements previously described and illustrated were made. Means, standard errors of the means, standard deviations, and "t" test scores for small samples were made on all measurements and recorded in the preceding tables. The following discussion is the author's interpretation of this data.

The tongue was divided into fourths, the anterior 1/4 or apex, 1/4 of the tongue dorsum in the region of the cuspid teeth, middle 1/4 or area associated with the molar teeth and posterior 1/4 or base of the tongue. The measurements of the tongue posture will be discussed in an anterior-posterior manner starting from the apex anteriorly to the posterior pharyngeal wall posteriorly.

Ten cases indicated a slight advance of the apex of the tongue when the mandible changes posture from occlusion to rest. This slight anterior movement was not statistically significant, however, but did occur. In eight patients, the apex of the tongue withdrew slightly from A-B plane with four patients tongue's remaining unchanged by a shift in posture of the mandible. The over-all posture change in relation to A-B plane was a slight distal movement of the apex of the tongue.

Twelve measurements relating the apex of the tongue to the denture indicate a distal movement of the apex. Only six cases showed a mesial or forward tendency of the apex of the tongue movement in relationship to the teeth. Four cases showed no postural change in the apex of the tongue.

In accordance with the idea that a downward and backward movement of the mandible results in a slight distal movement of the apex of the tongue, results show in fourteen of the cases studied an increase in height of the apex, or the apex became slightly elevated. Seven cases show a lowering of the apex of the tongue below its original position when the mandible was in occlusion. Only in one case did the apex remain unchanged.

The vertical measurement of the apex of the tongue is the weakest measurement included in this study as far as reproducibility is concerned. The reason for its weakness is the difficulty in obtaining a definite point for the apex. In many cases it had to be estimated because the apex had a tendency to flatten out and become thickened, thereby resulting in difficulty in location.

Consideration was given to the idea that if during the downward and backward shift of the mandible the apex of the tongue moved distally and superiorly, the dorsum of the tongue should closer approximate the palate. To prove or disprove this theory, the vertical measurements of the dorsum of the tongue were made.

The dorsum of the tongue in thirteen cases dropped or decreased in vertical height in the anterior 1/4 or region of key ridge. In eight cases, the tongue dorsum increased in vertical height more closely approximating the hard palate and one case remained unchanged.

The middle 1/4 of the tongue dorsum had a tendency to increase and decrease in vertical height in relation to occlusal plane and mandibular plane. There were eleven cases showing an increase in vertical height of the tongue and ten cases, showing a decrease in vertical height of the tongue dorsum to mandibular plane. The tongue dorsum elevated superiorly in eight cases and descended in eleven cases when measured to occlusal plane.

The posterior 1/4 of the tongue in the region of posterior nasal spine or junction between hard and soft palate had a tendency to descend in fifteen cases and elevate in four cases with three cases remaining unchanged.

With the distal and vertical movement of the apex of the tongue and inferior descent of the anterior of 1/4 of the tongue associated with a superior elevation in the middle 1/4 and descent in the posterior 1/4, it would seem to stand to reason that the base of the tongue would move away from the posterior pharyngeal wall and closer approximate the soft palate velum.

In fourteen cases, the soft palate velum moved forward away from the posterior pharyngeal wall and six cases revealed a reversal of this movement. The base of the tongue in fourteen cases moved distally or toward the pharyngeal wall and in six cases moved forward or away from the pharyngeal wall. This apparent shift in velum and tongue posture is thought to be due to the negative pressure exerted in the mouth with the downward and backward movement of the mandible when it moves from occlusion to rest.

The results obtained in this study show a correlation between the posture of the tongue and position of the mandible; however, the "t" test scores for each measurement were not significant (N.S.) at greater than 5 percent level of confidence and warrant a continuation of this study to increase the size of the sample to the point where any degree of chance could be ruled out.

**SUMMARY**

## SUMMARY

The tongue being a complex organ and difficult to observe has fascinated many anatomists, oral histologists, orthodontists, pediatricians, pedodontists and other inquisitive minds. Its importance in swallowing, speech, deglutition, mastication, dental development and respiration has long been accepted.

With the advent of modern science, new avenues have been opened to inquisitive investigators. Most of the organs and organ systems of man have been surveyed, explored and in most cases have been followed from development in utero through adulthood. The tongue being one of the complex organs of the body has not been studied as extensively as other organs of the body for many reasons. Two of these reasons are inaccessibility of observation and its spontaneous rapid movements.

This study was designed through the use of one of the modern sciences' media of study, roentgenography. A technique was established by which roentgenography was used to show the tongue and its surrounding tissues and measurements then made to orientate the tongue in the oral cavity.

Twenty-two caucasian children of ages ranging from seven years eight months to sixteen years were included in this study. There were fifteen males and seven females. The results indicated a difference in the posture of the tongue between rest position of the mandible and occlusion of the mandible; however, the difference was not statistically significant at greater than the 5 percent level of confidence.

## CONCLUSIONS

## CONCLUSIONS

1. A definite technique has been established to study the posture of the tongue. This technique is based upon the use of a microopaque material (barium sulfate) and the Broadbent cephalometer unit.
2. The apex of the tongue moved distally from A-B plane and the denture when the mandible changed position from occlusion to rest in twelve cases.
3. The apex of the tongue in fourteen cases increased in height in relation to occlusal plane.
4. The vertical measurement of the apex of the tongue was the least reproducible measurement.
5. The dorsum of the tongue in thirteen cases dropped in the region of key ridge.
6. In fourteen cases, the soft palate velum moved forward or away from the posterior pharyngeal wall.
7. In fourteen cases, the base of the tongue moved forward or away from the posterior pharyngeal wall.
8. The results obtained in this study indicated a difference in the posture of the tongue between rest position of the mandible and occlusion. The difference was not significant at greater than the five percent level of confidence.

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A Posture Study of the Tongue. La Forrest D. Garner, School of Dentistry, Indiana University, Indianapolis, Indiana. A study was undertaken to gain additional information relative to the posture of the tongue in twenty-two caucasian children with normal occlusions. The patients were positioned in a Broadbent Cephalometer unit and a thick mixture of micropaque (barium sulfate) applied to the patients tongue. Lateral roentgenographs were taken with the patients teeth in centric occlusion and with the mandible at rest. Tracings of the cranium and soft tissue were made on acetate tracing paper and nine measurements employing cephalometric and anatomical landmarks made. The tongue was divided into fourths. The anterior 1/4 or apex, 1/4 of the tongue dorsum in the region of the cuspid teeth, 1/4 of the tongue dorsum in the region of the first and second molar teeth, and posterior 1/4 or base of the tongue in the region of posterior nasal spine (junction between hard and soft palate). The results suggested the tongue in over 50 percent of the cases changed its posture in all planes of space when the mandible changed positions from occlusion to rest. The change in positions by the mandible from occlusion to rest resulted in the following changes in tongue posture. In 54 percent of the cases the apex of the tongue moved distally away from the denture. In 59 percent of the cases the tongue dorsum in the cuspid area decreased in vertical height. In the cases incorporated in this study both increases and decreases in vertical height of the tongue were observed in the region of the molar teeth. There was a forward movement of the base of the tongue in relation to posterior pharyngeal wall in 63 percent of the cases.