Cinefluorographic Study of Functional Adaptation of the Oropharyngeal Structures

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INTRODUCTION

The famous architect Frank Lloyd Wright has said that form and function are one. This architectural concept may in general be considered true for the biological sciences as well. However, the relationship between the hard structures of the head and neck and their related soft tissues has yet to be fully explained. Opinions vary as to which structure has a dominant influence on the other.

It has been generally accepted in dental literature that the dentoalveolar structures are in a position of equilibrium with the enveloping soft tissues. Brodie[1] stated that the final position of the teeth and alveolar structures is determined by the muscular forces that surround them.

In recent years, however, the equilibrium theory has been contradicted by various investigators. Myometric studies by Kydd[2] and Winders[3] suggested that in function there was an imbalance of forces acting on the dentition. These workers found that the tongue could exert more pressure on the teeth than the buccal musculature. Using force-sensitive tranducers McNulty et al.[4] showed that the perioral musculature has a marked ability to adapt to changes in the local dental environment. Cleall[5] used a standardized cinefluorographic technique to study the posture and function of the oropharyngeal structures in deglutition. One of his findings was that the soft tissues displayed a marked ability to adapt to local changes in the environment and that the positional changes that occur during deglutition were largely in accord with the dictates set by the local skeletodental configuration.

The tongue, both in posture and function, has been generally considered to be one of the main moulding forces within the oral environment. Since abnormal tongue behaviour is found in many cases of malocclusion, it has been suggested that dental and skeletal malrelationships can be caused by such conditions as atypical swallowing and tongue thrust. Clinical studies by Rix[6] and Straub[7] stressed the dominant effect of abnormal tongue behaviour on the position of the dental structures. More recently, studies by Ballard[8] and Tulley[9] imply that too much attention has been placed on tongue thrusting in orthodontic problems. According to these authors, more emphasis should be placed on the morphology of the skeletal and soft tissues which demand abnormal posture and activity rather than on the more transient and rapid movements of the tongue in deglutition and speech.

Clinical studies such as those by Bell and Hale[10] and Ward et al.[11] have indicated that tongue thrusting and speech difficulties may be a normal occurrence in children during that period when the deciduous incisors are lost. It was hoped, therefore, that an objective study using a cinefluorographic technique would provide information as to the manner in which the soft tissues adapt to a change in environment which occurs when the deciduous maxillary central incisors are exfoliated and subsequently

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replaced by their permanent successors. It was also hoped that such a study would indicate whether the eruption pattern of the permanent incisors was related in any way to the behaviour of the soft tissues.

Material and Methods

A cinefluorographic technique was used to measure any changes in the posture and function of the oropharyngeal structures that occurred in the interval between the following physiological developmental phases:

Phase I. When the maxillary deciduous central incisors were present.

Phase II. After the maxillary deciduous central incisors were exfoliated but before the appearance of their permanent successors.

Phase III. After the maxillary permanent central incisors had erupted and reached the plane of occlusion and established some degree of overbite (Fig. 1).

The sample consisted of twenty-two Caucasian subjects of whom ten were male and twelve female; when the first records were taken the average age was 6 years 8 months.

Selection was based on an acceptable skeletal pattern and good Class I occlusion with no history of previous orthodontic treatment or speech therapy. Those with previously diagnosed tongue thrust patterns were also excluded.

Records taken at each developmental phase included: lateral cephalometric radiographs, study models, a standardized cinefluorographic sequence involving speech and deglutition, and an assessment of any changes in speech pattern or swallowing behaviour.

In the filming of the cinefluorographic sequence a thin smear of radioopaque paste was applied to the subject's tongue and lips. The subject was then positioned for screening and stood upright in a relaxed manner with his eyes looking directly ahead. The subject was instructed to take a small sip of water, to swallow it on cue, and then to repeat the following sentence: "Peter looks silly swimming." This sentence contains several plosive and sibilant sounds and was said several times in an unhurried manner. During the pause

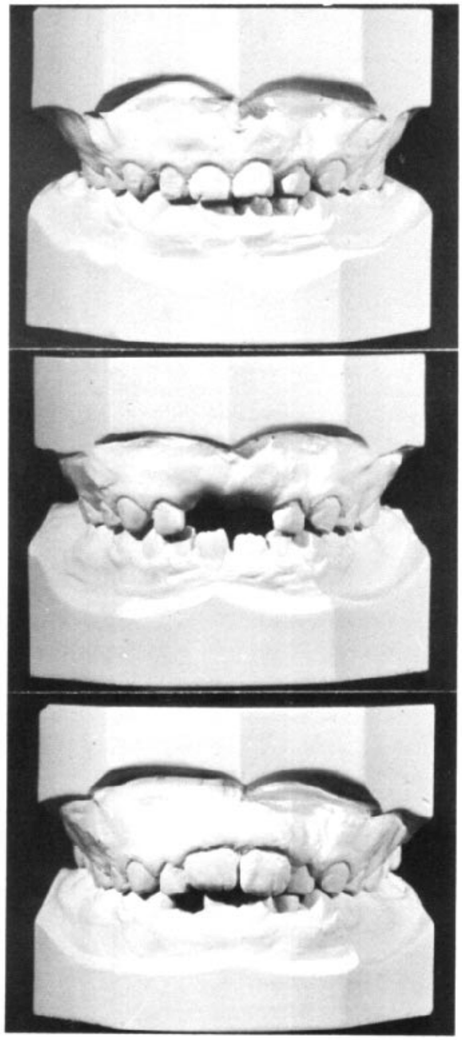


Fig. 1 Models showing phases at which records were taken. Phase I top, Phase II middle, Phase III bottom.

between each sentence, several demand and nondemand swallows were made and recorded.

Cinefluorographic Equipment

The basic principles of cinefluorography have been adequately described by Ramsay[12] et al., Moll[13] and Cleall.[5] In this study the equipment consisted of an x-ray source and a Picker 7-inch automatic electronic image intensifier which was synchronized with a 16 mm movie camera set to run at 30 frames per second. As the cinefluorographic unit was not standardized, linear measurements were corrected by comparing the palatal length on the cine to that measured on the cephalometric radiograph (Yip[14]).

Analysis of Records

Cephalometric Records—An analysis was made of each cephalometric radiograph (Fig. 2). A total of twelve angular and seven linear measurements were recorded. The behaviour of the maxillary and mandibular central incisors during eruption was felt to be of interest, and angular measurements were used to relate these teeth to SN, the palatal plane and the mandibular plane. In this manner it was hoped to assess both positional and angular changes of these teeth. The tracing of the maxillary and mandibular incisors represents some difficulty when these teeth are erupting and the roots have not fully formed. The method used was similar to that described by Fletcher.[15] A template of the complete incisor was drawn from the last radiograph taken in phase III. The outline of this incisor was then transferred to the previously taken radiographs in phases I and II by superimposing the template on the outline of the crown and as much of the root area as had formed.

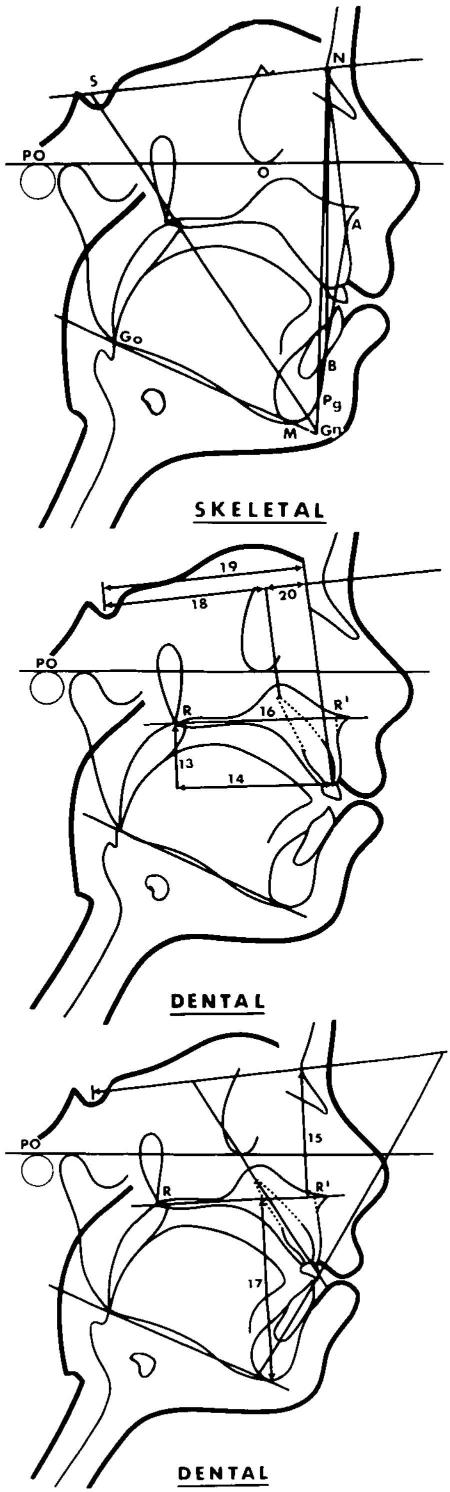


Fig. 2 Illustration of cephalometric analysis.

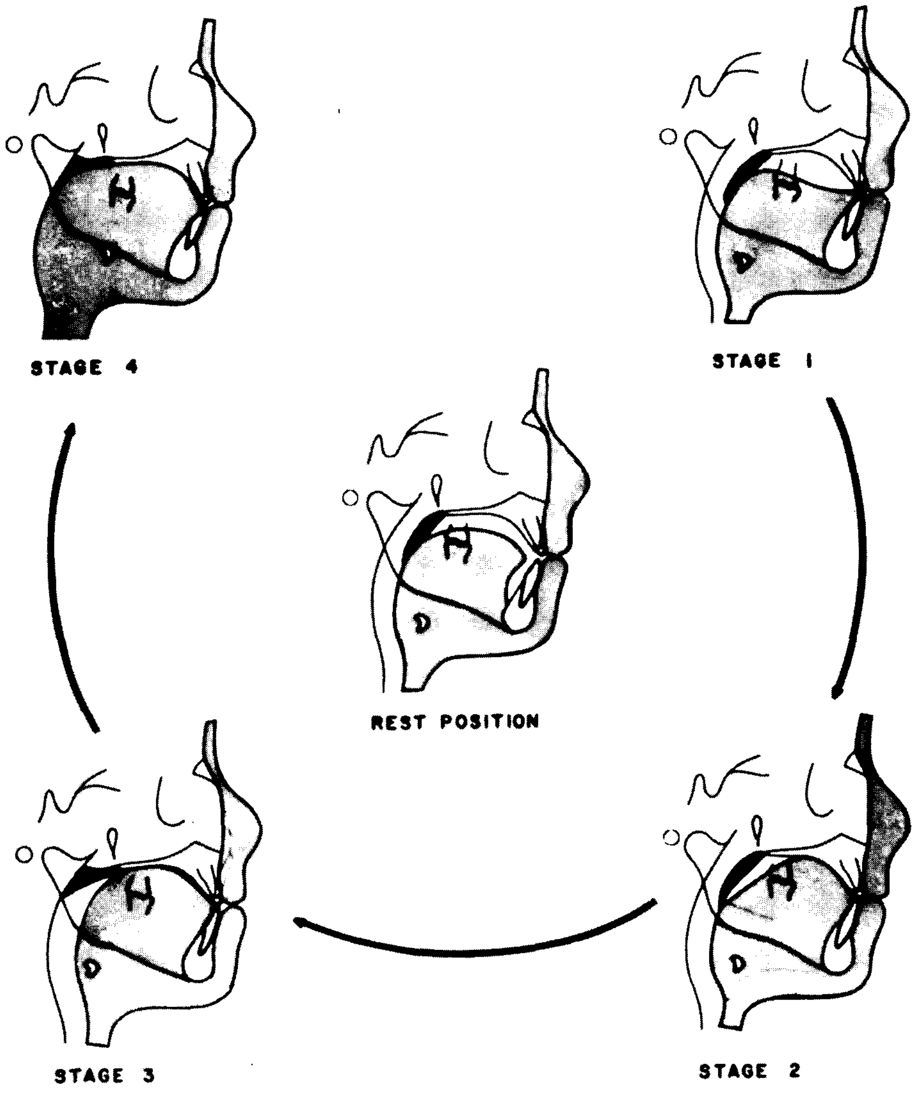


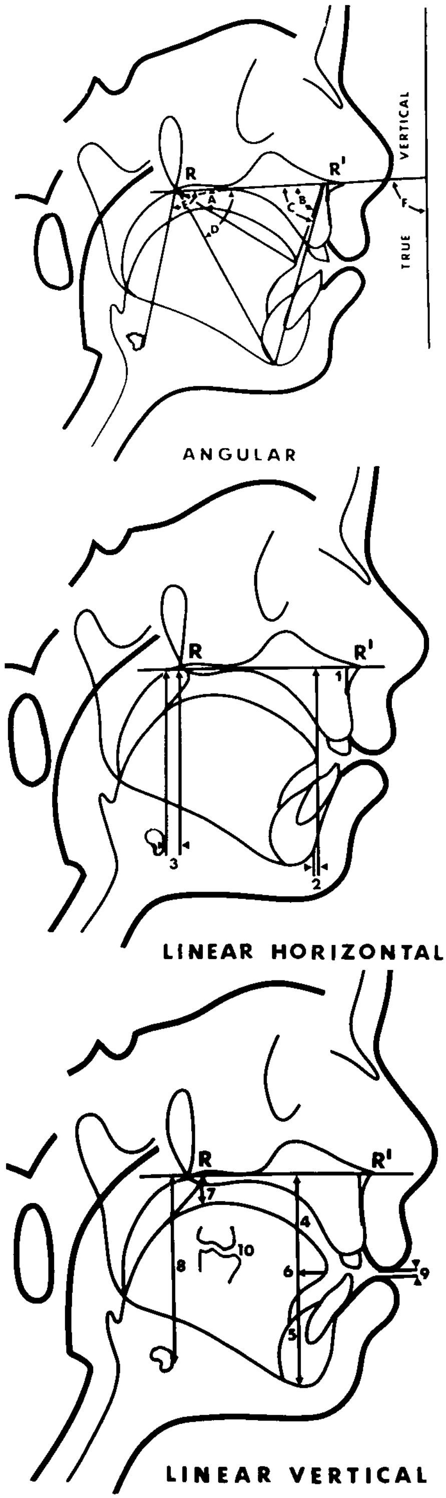
Fig. 3 Illustration of frames selected from deglutition and rest position.

Cinefluorographic Records — A Tagarno 16 mm movie editing projector was used to select individual frames for analysis. The film was then transferred to a Vanguard Motion Analyzer which enabled the recording of both angular and linear measurements of the following stages of deglutition (Fig. 3):

Stage 1—When the tongue moves forward to make contact with the lingual surface of the upper incisors or the palatal mucosa.

Stage 2—When the tongue has made contact with the anterior portion of the vault of the palate.

Stage 3 — When the tongue has reached the junction of the hard and soft palates and the soft palate is elevated to contact the posterior pharyngeal wall.



Stage 4—When the hyoid bone has reached its most anterior superior elevation.

A standardized set of linear and angular measurements was used to analyze each frame selected (Fig. 4). This analysis was designed to detect horizontal and vertical changes in the positions of the oropharyngeal structures at the three developmental phases studied. The specific structures under observation were: the tip of the tongue, dorsum of the tongue, the mandible, lips, hyoid bone, molar separation and head posture. A total of six angular and ten linear measurements were recorded using the palatal plane for reference and the vertical projection of PTM and point A to this plane as registration points.

Linear Measurements

Length 1. The horizontal distance from the tongue tip to R^1.

Length 2. The horizontal distance from the tongue tip to pogonion.

Length 3. The horizontal distance from the anterior point of the body of the hyoid bone to R.

Length 4. The vertical distance from the tongue tip to the palatal plane.

Length 5. The vertical distance from the tongue tip to menton.

Length 6. The vertical distance from menton to palatal plane.

Length 7. The vertical distance from the dorsum of the tongue to the palatal plane.

Length 8. The vertical distance from the most anterior part of the body of the hyoid bone to the palatal plane.

Length 9. The vertical distance separating the lips at the narrowest point.

Fig. 4 Illustration of cinefluorographic analysis. This analysis was based on the palatal plane and was registered at vertical projection of PTM or point A to this plane.

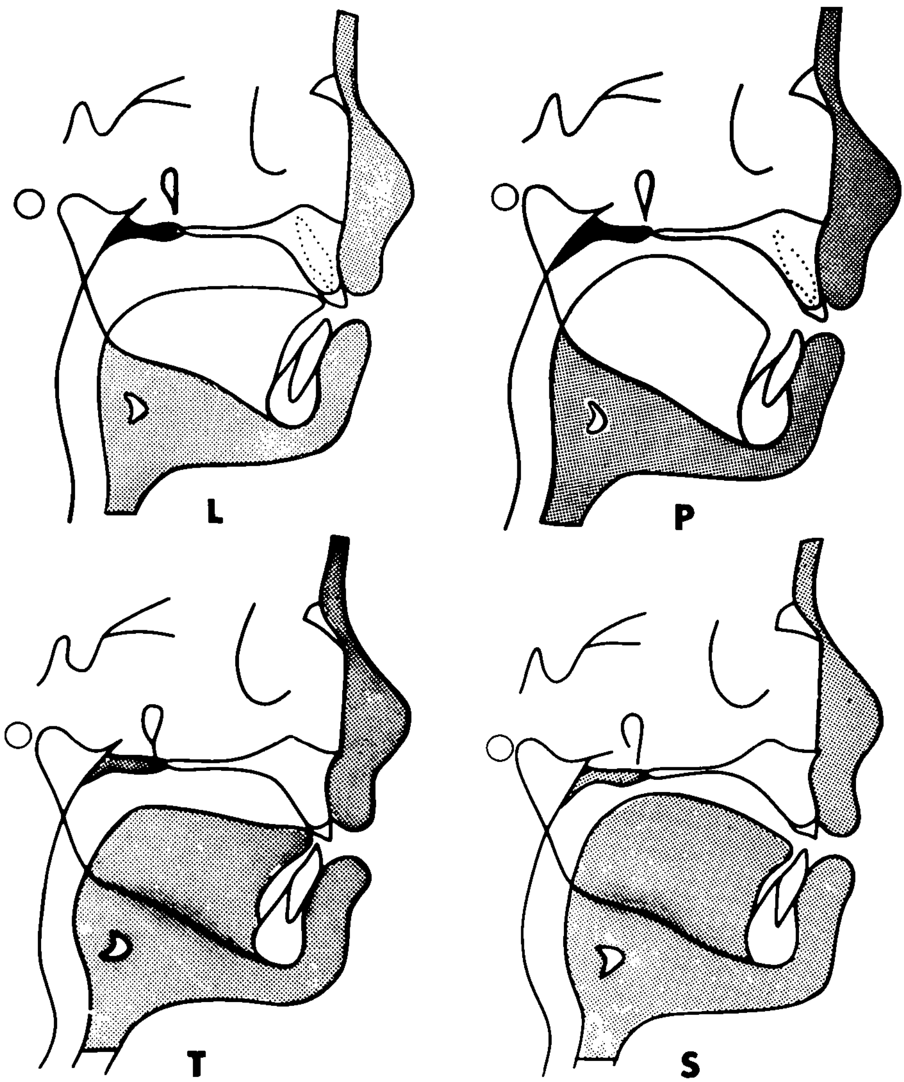


Fig. 5 Illustration of frames selected from the various speech sounds.

Length 10. The vertical distance between the cusps of the maxillary and the mandibular first permanent molars or the second deciduous molars.

Angular Measurements

Angle A. The angle formed by the tongue tip and the palatal plane centered at R.

Angle B. The angle formed by the tongue tip and the palatal plane centered at R^1.

Angle C., The angle formed by menton and the palatal plane centered at R^1.

Angle D. The angle formed by menton and the palatal plane registered at R.

Angle E. The angle formed by the most anterior point on the body of the hyoid bone and the palatal plane centered at R.

TABLE I

Analysis of Variance for selected cephalometric variants
(Angles in degrees and vertical and horizontal measurements in mm)

VARIANT	PH I	PH II	PH III	F
U. 1 To SN (angle)	102.7	105	104.1	
U. 1 To PAL PL (angle)	109.5	110.9	110.2	
U. 1 To L. 1 (angle)	134.6	131.3	130.5	* (1,3)
L. 1 To M.P. (angle)	89.4	90.9	92.8	** (2,3)
L. 1 To SN (angle)	56.6	55.1	54.3	* (1,3)
U. 1 To PAL PL (ver)	14.6	18.3	22.6	**(1,2,3)
U. 1 To PTM (hor)	39.6	41.1	43.5	**(1,2,3)
N. To PAL PL (ver)	41.2	41.6	42.1	**(1,2,3)
MENTON To PAL PL (ver)	51.9	51.5	51.6	
S To U. 1 APEX	46.5	46.7	49.3	**(2,3)
S To U. 1 CROWN	51.9	53.4	55.1	**(1,2,3)
APEX To CROWN	5.5	6.5	6	

1 - Difference is significant between Phase I and Phase II.

2 - " " " " Phase II and Phase III.

3 - " " " " Phase I and Phase III.

** - Significant at the .01 level.

* - Significant at the .05 level.

Angle F. The angle formed by the intersection of the palatal plane and the true vertical which is marked on each frame.

A similar analysis was performed on the selected speech sounds (Fig. 5).

Statistical Analysis

All the data were subjected to a standard statistical evaluation which included means, standard errors, significance tests (F) and correlation coefficients (r). The effects of phase differences on each of the linear and angular variants were studied using an analysis of variance following a factorial complete block design.

Results

Cephalometric Results

In order to characterize the sample, a comparison was made with the data from other samples. The Winnipeg sample was found to compare favourably. Of more significance to the present study was the occurrence of changes in the relations of the dental structures between phases. The angular relationship of the maxillary central incisor to SN and the palatal plane showed no significant change between the three phases under study (Table 1). The angle that the mandibular central incisor formed with the mandibular plane and SN showed significant changes at

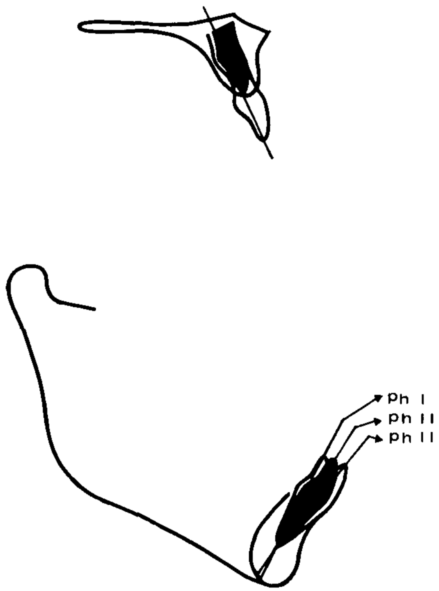


Fig. 6 Composite diagram based on cephalometric results showing eruption pattern of maxillary incisor relative to the palatal plane and mandibular incisor relative to the mandibular plane. Phase I: deciduous incisors, Phase II after the loss of upper deciduous incisors and Phase III after eruption of upper permanent incisors.

the .01 and .05 level respectively, indicating a progressive proclination between phases for this tooth.

The analysis of the linear measurements indicated that the maxillary permanent central incisor was translated bodily downward and forward along a line formed by its long axis. Figure 6 shows composite diagrams based on the cephalometric means of the eruption pattern of the maxillary and mandibular central incisors.

Cinefluorographic Results

Table II and Figures 7 and 8 show some of the results obtained from the cinefluorographic analysis.

1. Changes in Tongue Position—The analysis revealed that between phases the tongue tip at rest showed a tendency to be positioned forward in phase II and backward in phase III. Although this pattern of change was not statistically significant, it was found in sixty-five per cent of the subjects.

In deglutition the tongue tip was positioned forward in phase II and backward in phase III. This change in tongue position was highly significant between each phase at the .01 level and this pattern of change occurred in seventy per cent of the sample (Table II). In the vertical plane the position of the tongue tip in deglutition appeared to be influenced by the erupting maxillary incisor and followed this tooth in its downward path.

The analysis of the frames representing the various speech sounds indicated that in general the tongue tip was positioned forward in phase II and backward in phase III. This change was highly significant at the .01 level for the T sound and since this sound is made with the tongue in a lingual-dental position, this change might have been expected. However, the same tendency was also present for the P, L and S sounds (Table II and Fig. 8). In the vertical plane the position of the tongue tip appeared to vary with the sound being produced. Figures 7 and 8 are composite diagrams based on these results showing the changes mentioned in deglutition and the speech sounds.

2. Changes in Hyoid Position — Changes in the hyoid bone position were found to be statistically significant in the rest position only. However, similar patterns of change were found in deglutition. At rest the hyoid bone was found to be located forward in phase II and backward in phase III. In the vertical plane, however, the hyoid bone was positioned vertically downward between phases.

In deglutition a similar pattern of change emerged with the hyoid bone being positioned forward in phase II and backward in phase III. Again in

TABLE II

Means and Difference of Means For Selected Cinefluorographic Variants (in mm)

VARIANT	FUNCTION***	PH I	PH. II	PH III	F
	R	6.4	6.1	6.2	
	1	4.9	2.7	3.8	** (1,2,3)
Length 1	2	4.6	2.9	3.8	** (1,2,3)
	3	4.8	2.9	4.0	** (1,2,3)
	4	4.9	3.3	4.2	** (1,2,3)
	P	8.2	7.9	7.2	
Length 1	T	4.7	3.2	4.4	** (1,2)
	L	5.2	4.2	4.3	
	S	7.9	7.6	7.9	
	R	4.4	2.4	4.9	* (1,2)
	1	4.1	4.6	5.0	
Length 3	2	5.2	4.5	5.4	
	3	4.9	3.5	4.5	
	4	-1.1	-0.7	-1.2	
	R	20.7	21.7	20.9	
	1	18.8	19.0	19.2	
Length 4	2	19.0	19.3	19.4	
	3	19.4	19.1	19.6	
	4	19.8	19.3	19.5	
	P	22.0	23.2	21.7	** (1,2)
Length 4	T	18.9	19.7	19.0	
	L	20.7	19.7	18.0	** (1,2,3)
	S	22.3	21.7	22.5	
	R	43.0	45.2	45.1	* (1,3)
	1	41.4	42.6	43.8	
Length 8	2	40.8	41.1	41.8	
	3	38.6	38.5	39.8	
	4	39.6	40.1	39.8	

** = Significant at the .01 level.
* = Significant at the .05 level.
1 = Difference is significant between phase I and phase II.
2 = Difference is significant between phase II and phase III.
3 = Difference is significant between phase I and phase III.
*** = R = rest; 1,2,3, and 4 = the four stages of deglutition, P,T,L, S = the four speech sounds studied.

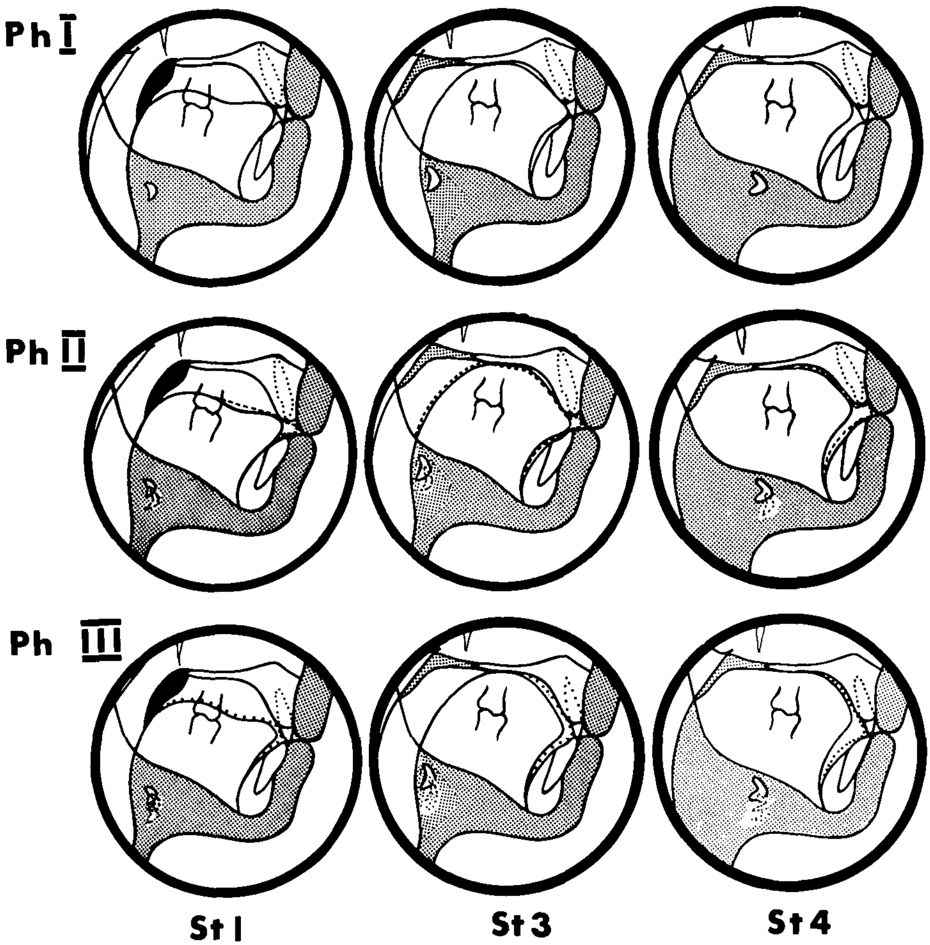


Fig. 7 Composite diagrams of changes in tongue and hyoid bone in stages 1, 3, and 4 of deglutition. Phase I: deciduous incisors, Phase II after the loss of upper deciduous incisors, and Phase III after eruption of upper permanent incisors.

the vertical plane the hyoid bone was located progressively downward between phases.

In speech the pattern of change was slightly different. In the horizontal plane the hyoid bone was positioned progressively forward between phases while in the vertical plane no obvious change was noted.

In deglutition and at rest the hyoid bone displayed positional changes which were similar to those reported earlier for the tongue tip in these functions. In speech, however, the changes in tongue tip position were not reflected in similar changes in the position of the hyoid bone. It must be remembered that in deglutition and at rest the tongue tip and hyoid bone are intimately associated with the vital function of respiration and, as such, it might be expected that their function would show this coordination. In speech it would appear that the tongue tip can function in part independently of the structures in the posterior part of the mouth.

3. Changes in Mandibular Position—It was found that changes in mandibu-

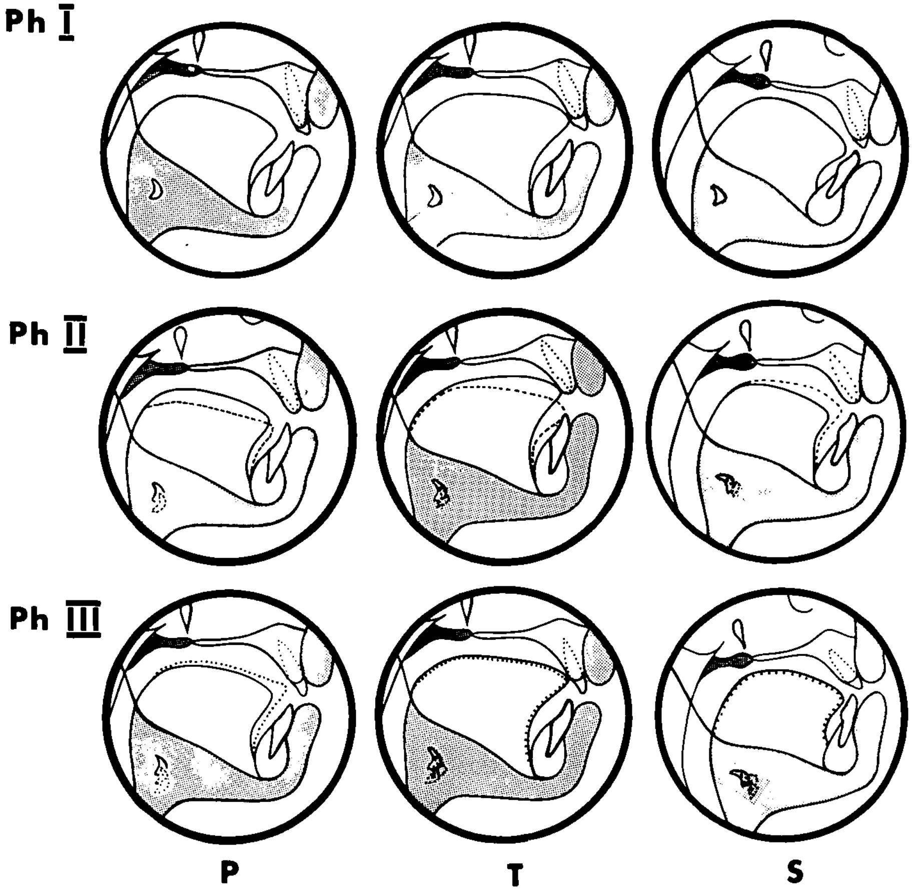


Fig. 8 Composite diagrams of changes in tongue and hyoid bone position in P, T, and S sounds. Phase I: deciduous incisors, Phase II after the loss of upper deciduous incisors and Phase III after eruption of upper permanent incisors.

lar position varied within the three functions under study.

In the rest position when the maxillary deciduous central incisors were shed the distance from the palatal plane to menton increased. After the permanent central incisors had erupted, the mandible resumed its former position relative to the palatal plane. In the anteroposterior plane, the mandible was located progressively forward. In deglutition very little change was detected in mandibular position in both anteroposterior and vertical directions. During speech, changes in the vertical distance from the mandible to the palatal plane varied with the sound being produced, but were similar to the changes in tongue-tip position for the same sounds.

4. Time Analysis—The time analysis for the intervals between successive stages of deglutition is shown in Table III.

It was of interest to find that the time for the complete deglutition cycle decreased over the three phases studied. It might have been expected that the tongue thrust detected in phase II would have caused an increase in the time required for deglutition. However, the fact that this was not so may be an

TABLE III

Time Analysis of Deglutition (in seconds)

STAGE	PH. I	PH. II	PH. III	F
Stage 1-2	.24	.19	.20	
Stage 2-3	.33	.27	.21	** (1, 2, 3)
Stage 3-4	.36	.31	.36	
TOTAL	.93	.77	.76	

** = Significant at .01 level.
1 = Difference is significant between phase I and phase II.
2 = Difference is significant between phase II and phase III.
3 = Difference is significant between phase III and phase I.

illustration of the adaptive qualities of the oropharyngeal structures. It may also indicate the presence of a maturational process in deglutition.

5. Lip Separation—At rest there was a progressive shortening of the distance between the lips over the three phases under study. When the records were examined, it was found that in phase I nine subjects had their lips apart; in phase II six subjects had their lips apart, and in phase III four subjects had their lips apart. Thus both the degree and prevalence of lip separation decreased progressively over the three phases.

In deglutition a different pattern of change emerged. In phase II there was a reduction in the degree of lip separation and in phase III there appeared to be an increase again. It may be inferred therefore, that in phase II there is a tendency to bring the lips together to provide a seal with the tongue which, as has been reported, is postured forward when the maxillary deciduous central incisors are shed.

For the individual speech sounds the loss of the maxillary deciduous incisors in phase II appeared to influence the degree of lip separation in a manner that varied with the sound being produced.

6. Molar Separation—Molar separation was measured as the vertical distance between the tip of the cusps of the maxillary and mandibular first permanent molars or second deciduous molars.

During deglutition there was a progressive reduction in this distance. Of equal importance was the finding that thirteen individuals swallowed with their teeth apart in phase I. Of these, nine continued to swallow with their teeth apart in phase II. After the maxillary permanent incisors had erupted only seven individuals were found to swallow with their teeth apart. These results suggest that in this age range there is a progressive reduction in the degree and prevalence of tooth-apart swallow which is not influenced by the loss of the maxillary deciduous central incisors in phase II.

7. Coefficient of Correlation (r)—Correlation coefficients were obtained for a selection of twenty-two pairs of variables from the cinefluorographic analysis and ten pairs of variables combining cephalometric and cinefluorographic variants (Table IV).

The results indicated that in a horizontal plane, while the tongue, mandible and hyoid function as an integrated unit during deglutition and at rest, the correlations become much stronger after the maxillary permanent incisors have erupted. This implies that a maturational process is also present

Table IV

Correlation Coefficients For Selected

Cinefluorographic Variants

FUNCTION	VARIANTS	PH I	PH II	PH III
Rest	Angle B:Angle E		*	**
	Length 1:Length 3			**
	Angle C:Length 3		*	**
Stage 2	Angle B:Angle E			**
	Length 1:Length 3			**
	Angle C:Length 3			**
	Angle B:Angle C	**	**	**
Stage 1	Length 1:Length 6		-**	
Stage 2	Length 1:Length 6			
Stage 3	Length 1:Length 6		-**	
Stage 4	Length 1:Length 6		-**	
Rest		**	**	
Stage 1	Length 4:Angle B		**	
Stage 2	Length 4:Angle B		**	
Stage 3	Length 4:Angle B		**	
Stage 4	Length 4:Angle B		**	

** = Significant at the .01 level.
* = Significant at the .05 level.

controlling the integration of the oropharyngeal structures.

The correlation coefficient for the anteroposterior position of the tongue and the degree of mandibular opening was strongly negative in phase II only. This indicates that, as the tongue was postured forward, the mandible tended to drop.

Finally, the correlation coefficients comparing the anteroposterior position of the tongue with various cephalometric variants were calculated. The most significant finding was that the anteroposterior position of the tongue correlated strongly with the convexity of the profile. However, no correlation value of any significance could be found for the relation of the anteroposterior position of the tongue and the position of the maxillary permanent incisor.

Discussion

Previous studies by Cleall et al.[16] demonstrated that there is a marked variation in the posture and function of the oropharyngeal structures between subjects, but that these functions were fairly constant within the individual. The results of the present study support this finding. In addition, it was also possible to detect common patterns of change in posture and function of the oropharyngeal structures. For certain variants these patterns of change appeared to be associated with the changes in the dental structures. For other variants the changes appeared to be related to a maturational process.

The present study has shown objectively that, although there is a marked increase in tongue thrusting when the maxillary incisors are lost, this must be considered an adaptive measure to changes in the local environment. The findings also imply that the prevalence of tongue thrust may be considered a normal but transient occurrence during this developmental period. This adaptive capacity was also evident in the position of the tongue tip in the various speech sounds. Although changes in the anteroposterior and vertical planes varied with the sound being produced, these changes appeared to result in a tongue tip position most favourable for each particular sound. A similar finding was reported by Benediktsson.[17]

These adaptive movements were not confined to the anterior part of the mouth and evidence was found to suggest that the pharyngeal structures associated with the hyoid bone also show some subtle adaptive movements in harmony with the tongue movements. The hyoid bone is intimately linked with the lingual, pharyngeal and suspensory system and, as such, its positional changes are characteristic of the integration of the various structures involved in deglutition. Sloan et al.[18] have described the hyoid bone as the "mirror of function." The fact that in deglutition the tongue tip adapted considerably to the anterior environment while the hyoid bone displayed minor changes suggests that the tongue tip and pharyngeal structures are capable of acting, in part, independently. It is probable that the adaptive movements of the hyoid bone are limited to those which would not interfere with the maintenance of an adequate airway as has been suggested by Brodie[19] and Bosma.[20]

It has been suggested that abnormal tongue thrusting and speech difficulties arising in the transitional dentition stage may be retained and produce some form of malocclusion. However, the results of this study do not agree with this concept. Those subjects who were found to posture the tongue forward when the maxillary deciduous central incisors were shed returned to their original pattern of swallowing when the permanent incisors had erupted.

When the deciduous incisors were missing, an increase in speech distortion was detected, particularly in the S and T sounds. The cinefluorographic records indicated that the tongue adapted progressively to the changing oral environment and no obvious speech imperfections were found at the end of the period of study. This suggests that any abnormal tongue behaviour or speech disorder found in subjects after this developmental phase would probably be found to be present in the earlier complete deciduous dentition. However, it does not preclude the possibility that psychological or neurological problems may arise during this phase and intercept or prevent the adaptive movements noted.

The concept that the teeth are guided into their final position by the surrounding musculature is generally accepted by most orthodontists. The results of the present study appear to modify this concept. It was found that the maxillary permanent central incisor did not show any consistent pattern of change in angulation in its path of eruption. Instead it appeared to be translated bodily downward and forward along a line formed by its long axis. At the same time the oropharyngeal structures demonstrated a marked ability to adapt to the changing environment and appeared to be directly influenced by the erupting incisor. It might be construed, therefore, that the teeth erupt in harmony with the morphology of the skeletal pattern. Further support for this was found in the correlations between the cephalometric variants and the cinefluorographic variants. A highly significant correlation was found between the convexity of the skeletal profile and the degree of tongue thrust that occurred when the maxillary deciduous central incisors were shed. Conversely, a weaker correlation was found between the degree of tongue thrust and the angulation of the maxillary and mandibular permanent incisors. It is also interesting to note that, while the maxillary incisor did not reveal any consistent change in pattern of eruption, the mandibular incisor showed a progressive proclination over the period of study. It may be that the crowding usually present in the mandibular arch at this age is sufficient to cause this proclination or it may be caused by some other parameter not included in the present study.

The finding that the mandible, hyoid, and tongue work as an integrated unit both in function and at rest is in agreement with the findings of Cleall[5] and Yip.[14] The correlation coefficients in the present study also indicate that this integration is not evident until after the eruption of the maxillary central incisors. This implies that a maturational process is present at 6-8 years of age. Further indications of a maturational trend were also found in the time analysis of deglutition, the molar separation, and the lip separation. The presence of maturational factors in this age group agrees with clinical studies reported by Morley[21] and Fletcher et al.[22]

Leighton[23] followed a sample of children from 3 to 43 months using a combination of cinefluorography and cinematography. He concluded that patterns of oromuscular behaviour are probably endogenous and arise independently of skeletal morphology and precede rather than follow changes that later become associated with the skeletal morphology. He further implied that maturation may have little effect on these patterns of oromuscular behaviour. However, the results of the present study suggest that skeletal morphology may dictate function and that maturation does in fact play a significant role in the posture and function of the soft tissues.

It was originally considered that a normal swallow occurred when the tongue remained within the confines of the oral cavity, the lips remained in repose, and the posterior teeth came into contact, especially in the final stages of deglutition. Rosenblum[24] has shown that facial repose is not a necessary prerequisite for a normal swallow and Cleall[5] has demonstrated that the teeth need not necessarily come into contact in the final stages of deglutition. The present study would further suggest that the presence of a tongue thrust may not necessarily be detrimental to the occlusion. Accordingly, it is suggested that the term "physiologic tongue thrust" might be used in those instances where it is considered that the tongue is merely adapting to the environment.

Collectively, these conclusions suggest that a more liberal definition of what constitutes a normal swallow is required.

Summary and Conclusions

A cinefluorographic technique was used to objectively measure any changes that occurred in the posture and function of the oropharyngeal structures during the transitional dentition stage. An attempt was also made to compare these changes with the eruption pattern of the maxillary permanent central incisors.

The statistical results and subjective appraisal suggest the following conclusions:

1. There is a significant variation between subjects in the posture and function of the oropharyngeal structures.

2. The oropharyngeal structures demonstrated a marked ability to adapt to changes in the local dental environment.
3. In deglutition, when the deciduous central incisors were exfoliated, the tongue was postured forward. After the maxillary permanent central incisors had erupted, the tongue was retracted. A similar tendency was detected during speech and with the structures in the rest position.
4. A tongue thrust may not be detrimental to the occlusion in certain instances. It is suggested that the term "physiologic tongue thrust" might be used when it appears that the tongue is merely adapting to the environment.
5. In speech the tongue tip adapted to the changed environment. This resulted in a tongue position most favorable for the production of each particular sound.
6. The tongue, hyoid, and mandible appear to work as an integrated unit.
7. Several maturational factors were observed. During the period of study there appeared to be a reduction in the degree and prevalence of tooth apart swallow. The degree of integration between the oropharyngeal structures also showed a maturational trend.
8. Although an increase in tongue thrust and prevalence of speech distortion was found when the maxillary deciduous central incisors were exfoliated, these habits were not retained after the maxillary permanent incisors had erupted. These observations suggest that any abnormal tongue behaviour or speech disorders found in subjects after this developmental phase would probably also be present in the earlier complete deciduous dentition.
9. The maxillary permanent incisor showed no consistent pattern of change during eruption but the mandibular incisor showed a progressive proclination over the period of study.

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