Research Article

Investigation of the efficacy of a treatment program for deviant swallowing and allied problems

Charles P. Overstake

Suggested Citation

Overstake, C. P. (1975). Investigation of the efficacy of a treatment program for deviant swallowing and allied problems. *International Journal of Oral Myology*, 1(3), 87-104.

DOI: <https://doi.org/10.52010/ijom.1975.1.3.5>

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](#).

The views expressed in this article are those of the authors and do not necessarily reflect the policies or positions of the International Association of Orofacial Myology (IAOM). Identification of specific products, programs, or equipment does not constitute or imply endorsement by the authors or the IAOM. The journal in which this article appears is hosted on [Digital Commons](#), an Elsevier platform.

Investigation of the Efficacy of a Treatment Program for Deviant Swallowing and Allied Problems

Charles P. Overstake, Ph.D.
Wichita, Kansas

Director and Owner—Wichita Speech Science Laboratory, Wichita, Kansas. He was with Institute of Logopedics 22 years as Director of Professional Services, Head of Diagnostic Unit and preceptor. He taught on faculty of Wichita State University from 1955 to 1970. Dr. Overstake opened his own practice April 1, 1971. He has been involved with deviant swallowing problems and the correction of same since 1950.

Purpose and Procedures

This is the first part of three articles relating to the investigation.

The purpose of this study was to investigate the possible functional relationship within a triad of problems: (1) deviant swallowing, classified as tongue thrusting, (2) orthodontic problems of an openbite or overjet variety, and (3) interdental /S/ defects. The efficacy of a treatment program was determined for a group of children exhibiting this combination of problems. An orthodontic population, consisting of children referred to this investigator by orthodontists in private practice, was examined and all were diagnosed as having deviant anterior tongue-thrust swallowing, based on several kinesiological and dental diagnostic signs. The children with tongue-thrust swallowing who did not have the triad of problems were not used in this investigation. The children who did have the triad of problems were selected for further study and were designated as the "orthodontic" group. They were then randomly assigned to one of two orthodontic subgroups.

Specific swallow therapy was administered to all of the children. One subgroup was given swallow therapy and speech therapy for the interdental /S/ speech defect, while the other subgroup had swallow therapy only. Each of the subgroups received the specified therapy or therapies for a period of approximately nine months. Retest procedures were administered and improvement in each of the problem areas constituting the triad was assessed.

Then, a sample of children was taken from the total orthodontic group, according to age. One child was selected from each age group from seven through twelve years. These six children were further tested by electromyography to determine the muscle output for the muscles and muscle groups, identified in this study, as being significantly involved in swallowing.

Principal Research Question

Are deviant tongue-thrust swallowing, orthodontic problems of an openbite and/or overjet variety, and interdental /S/ speech defects so interrelated that swallow therapy procedures will, by themselves correct deviant swallowing, cause dental openbites and/or overjets to become more normal and correct interdental /S/ speech defects?

Operational Research Questions

The following questions were formulated to secure the necessary segments of information needed to answer the first part of the principal question.

1. Will the specified swallow therapy result in the establishment of normal swallowing patterns?
2. Will the electromyographic tracings of muscle activity and voluntary muscle energy output of a selected sample from the orthodontic group, after swallow therapy, resemble the normal or deviant swallowing group from the public school?

Selection of Subjects

Subjects were selected from an orthodontic population which was examined for children who had the specified triad of problems namely: (1) deviant swallowing, (2) openbite and/or overjet orthodontic problems, and (3) interdental /S/ speech sound defects. Children ranged in ages from seven years to twelve years.

This group of subjects consisted of school-age children who had already been or were being referred to orthodontists in private practice in Wichita. Referrals usually had been made by speech therapists, dentists and other orthodontists. This group was known as the orthodontic group.

Children from the orthodontic population found to have all three problems were assigned to one of two orthodontic subgroups used in this part of the study. Each subgroup had children seven through twelve years of age. Each subgroup had both male and female subjects. For the purpose of this investigation, it was desired that each subgroup have a minimum of twelve subjects.

Initial Examination Measures

All children seen in the orthodontic population were examined according to the procedures outlined. The principal measures were:

1. All children seen were visually examined for dental problems of an openbite and/or overjet variety.
2. All children seen were examined for normal or deviant tongue-thrust swallowing.
3. All children seen were tested for the presence of interdental /S/ speech sound defects.
4. The dental configuration of each child from the orthodontic group was photographed.
 - a. Photos were colored transparencies.
 - b. The lips and cheeks were pulled away from the teeth by cheek retractors.
 - c. Pictures were of the teeth only. Two pictures were taken, one at the level of the incisal edges of the anterior teeth and one at a 45-degree angle below the incisal edges to show the amount of overjet.

- d. A 35 millimeter camera with a special lighting device was used. A framing device, attached to the camera, insured the centering of the camera on the teeth and the maintenance of the same distance for each picture.

Assignment of Subjects

Originally seventy-six children from the orthodontic group comprised the two subgroups in this part of the study. Both orthodontic subgroup I and orthodontic subgroup II contained thirty-eight children.

The assignment of a child to either orthodontic subgroup was determined prior to his or her full examination. This examiner randomly determined that the "next" child to be examined, who had all of the problems making up the triad, would be placed in one or the other subgroup. Neither the severity of the dental problems nor the severity of the speech defect altered this pre-examination determination.

Group Matching Criteria

Experimental Variables. All children in both orthodontic subgroups were diagnosed as having deviant tongue-thrusting swallowing. All children had orthodontic problems of an openbite and/or overjet variety. All children were diagnosed as having interdental /S/ speech sound defects.

Age. The two subgroups were matched, insofar as each group had according to age, children from each age grouping represented, seven through twelve years. Groups contained both male and female subjects.

Intelligence. The same criteria used for the Public School groups were used. Any child whose composite percentile rank for the *Iowa Test of Basic Skills* fell below sixteen for the grade and school attended was not used.

Except for having the triad of problems, the orthodontic group of children used in Part II of this study were grouped on the same criteria as the normal and deviant swallowers from the public school population for sex, age and intelligence.

THERAPEUTIC PROCEDURES

Orthodontic Subgroup I

Children assigned to this subgroup were given swallow therapy only. Each child was on a variable time schedule for therapy. Each one was seen one week after the initial diagnostic and treatment session. After that there were therapeutic sessions scheduled at 2, 3, 4, 5, 6, 8, and 10 week intervals, extending over a nine-month period. Treatment in swallowing was formulated utilizing kinesiology principles and was based on the premise that normal swallowing could be taught by positioning the tongue and mandible in their proper postures just prior to the initiation of reflex swallowing behavior. Each therapy session lasted approximately fifteen minutes and was conducted by the investigator.

Parents were instructed each session relative to the home program for their child's swallowing practice. Specifically, swallow practice was to be done for five minutes before each meal using half a glass of water, milk or juice. Practice on different kinds of food was added during therapy, progressing from semi-solids to hard, chewy, difficult-to-swallow food.

Orthodontic Subgroup II

Children assigned to this subgroup were given both swallow and speech therapy. Procedures for swallow therapy were identical to those given to Orthodontic Group I. Procedures for speech therapy utilized an acoustic and phonetic placement approach. Speech practice was done for fifteen minutes before the child went to bed. Practice materials, word lists, phrases and sentences were suggested. Speech therapy sessions were given in addition to the swallow therapy; however, the combined sessions did not last more than fifteen minutes. Children in this group were seen on the same schedule as Group I, over a nine-month period.

The findings for this study will be presented in three parts: (1) The effects of swallow therapy on deviant swallowing; (2) the effects of swallow therapy on dental openbites and/or overjets; (3) the effects of swallow therapy only on interdental /S/ speech defects and the effects of swallow therapy and speech therapy on interdental /S/ speech defects.

The Effects of Swallow Therapy on Deviant Swallowing

Children assigned to both orthodontic subgroups received swallow therapy. The children in the Orthodontic Subgroup II also received speech therapy. Thirty-eight children were originally assigned to each of the subgroups; for various reasons, there was an attrition of subjects during the course of the investigation and the study was finally resolved with forty-eight children; twenty-eight in the swallow-only group, Group I, and twenty children in the speech-and-swallow group, Group II. The reasons for the children leaving the study were not numerous. The majority either moved from the community or were placed under orthodontic treatment by their parents. The latter treatment, of course, invalidated their continued participation in the study.

The children in both groups were re-examined after a therapy period of nine to ten months to determine whether or not they had developed the ability to swallow correctly. The original examination methods and the same diagnostic criteria, detailed earlier were used by the investigator to make these post-therapy judgments. In addition certain criteria were used to determine whether the "new" swallow pattern had become habituated: (1) the apparent smoothness and flexibility of the swallow, (2) the consistency in maintaining the tongue tip on the posterior portion of the gingiva, and (3) appropriate contraction of the temporalis and masseter muscles. Simple "yes" and "no" decisions were used by the investigator in marking these judgments.

Findings

Of the forty-eight children participating in this part of the study, forty-one, or 85 per cent, were judged to have developed swallow patterns after therapy that consistently were within normal limits. A breakdown of children by subgroups showed that for Group I, the swallow-only therapy group, 86 per cent, or twenty-four of twenty-eight children, showed essentially normal swallow patterns. For Group II, the speech-and-swallow group, 85 per cent, or seventeen of twenty children, showed patterns which were classified as normal.

These judgments were made after nine to ten months of swallow therapy. Of the remaining seven children who did not show normal swallowing at that time, all but two eventually developed normal swallowing apparently, they needed longer periods of time to develop a habitually acceptable pattern.

The children in this program who had learned normal swallowing during therapy were followed up at twelve-week and three-month intervals and all forty-one of them continued to show acceptable swallowing behavior.

To determine the statistical significance of these findings, the McNemar test for significance of changes were used. For the Orthodontic Subgroup I, swallow-therapy-only, an observed value of chi-square was found to be 22.04 which is significant beyond the .0005 level, when the direction of predicted difference is one-tailed. This level of significance permitted the conclusion that the children in the orthodontic Subgroup II as a group showed a significant change as a result of the therapy administered.

For the total orthodontic group, the McNemar test for the significance of changes was found to be 39.02 which is significant beyond the .0005 level. This finding also supported the decision to reject the hypothesis of no change.

Electromyographic Validation of Observed Swallow Therapy Results

A group of six children was selected from the total orthodontic group for further study. One child was selected at random from each of the six age groups. Each had been diagnosed as a deviant swallower, was given therapy, and was subsequently judged to have achieved normal swallowing. In an effort to validate the investigator's empirical, post-therapy judgment of "corrected" swallowing, the group of six was examined by electromyographic procedures which were identical to those used for the normal and deviant swallowers, selected from the public school population. The same muscles and muscle groups were tested and electromyographic tracings and voluntary muscle energy output data were obtained. The rationale for this testing was that if the deviant swallow had indeed been changed during therapy, the electromyographic data for such children should closely resemble the patterns obtained from the groups of normal swallowers than those obtained from the group of deviant swallowers.

The Anterior Temporalis Muscle

Measurements of the voluntary muscle energy output of the temporalis muscle were obtained on twelve swallows in four sets of swallows. Information concerning these measurements for the orthodontic group is presented in Table 1. For purpose of comparison similar data obtained for the normal and deviant swallowers from the public school group are also included. The table identifies the groups of orthodontic normal and deviant swallowers, the numbers of the swallows in sequence, the group means and standard deviations for each swallow.

Findings: The mean voluntary muscle energy output of the normal swallowers was 0.53 millivolts per millimeter and the mean output of the deviant swallowers was 0.59 millivolts per millimeter. The voluntary muscle energy output for the orthodontic group was 0.66 millivolts per millimeter with a standard deviation of 0.66. The F ratios revealed that the differences between these means were not significant. Figure 1, represents the mean voluntary muscle energy output for each swallow for each of the three groups. The muscle energy output for each group was somewhat parallel with some variability evident in the mean output from swallow to swallow. Of note is the increased output on the last three swallows when all groups made a parallel increase in voluntary muscle energy output.

The Masseter Muscle

Measurements of the voluntary muscle energy output of the masseter muscle were obtained on twelve swallows in four sets of swallows. Information concerning these measurements for the orthodontic group is presented in Table 2. For purpose of comparison, similar data obtained for the normal and deviant swallower from the public school group are also included. The Table identifies the groups of orthodontic, normal and deviant

Table 1. Electromyographic data: means and standard deviations, expressed in millivolts, of the voluntary muscle energy output of the Temporalis muscle expended by normal, deviant, and orthodontic swallows during each of twelve swallows

No. of Swallow	Normal Group N = 12		Deviant Group N = 12		Ortho. Group N = 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	0.28	0.22	0.41	0.16	0.68	0.87
2	0.35	0.28	0.34	0.18	0.59	0.72
3	0.43	0.46	0.39	0.18	0.48	0.55
4	0.33	0.31	0.41	0.21	0.50	0.58
5	0.28	0.23	0.43	0.32	0.56	0.65
6	0.42	0.45	0.49	0.23	0.60	0.71
7	0.51	0.38	0.35	0.18	0.62	0.81
8	0.46	0.39	0.54	0.35	0.53	0.68
9	0.66	0.68	0.43	0.13	0.52	0.57
10	0.95	0.61	1.02	0.35	0.99	0.72
11	0.84	0.39	1.25	0.38	0.93	0.72
12	0.92	0.47	1.08	0.29	0.91	0.48
Grand Means and Stand. Dev.	0.54	0.31	0.59	0.18	0.66	0.66
F-Ratio:	Nor. vs. Ortho. = 2.10		Nor. vs. Dev. = 0.25		Dev. vs. Ortho. = 0.40	
Level of Sig.	none significant					

Table 2. Electromyographic data: means and standard deviations, expressed in millivolts, of the voluntary muscle energy output of the Masseter muscle expended by normal, deviant, and orthodontic swallows during each of twelve swallows

No. of Swallow	Normal Group N = 12		Deviant Group N = 12		Ortho. Group N = 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	1.05	0.27	1.46	0.52	1.27	0.47
2	1.05	0.31	1.49	0.60	1.15	0.37
3	1.15	0.32	1.48	0.62	1.04	0.27
4	1.12	0.32	1.51	1.44	1.06	1.43
5	1.09	1.31	1.53	0.52	1.05	0.37
6	1.09	1.45	1.54	0.51	1.04	0.44
7	0.54	0.39	0.66	0.29	0.50	0.27
8	0.47	0.32	0.79	0.52	0.48	0.32
9	0.54	0.39	0.83	0.46	0.48	0.31
10	0.58	0.46	1.03	0.75	0.53	0.25
11	0.56	0.52	1.08	0.69	0.52	0.30
12	0.52	0.45	1.03	0.64	0.52	0.42
Grand means and Stand. Dev.	0.81	0.31	1.20	0.48	0.80	0.27
F-Ratio:	Nor. vs. Ortho. = .00		Nor. vs. Dev. = 9.29		Dev. vs. Ortho. = 9.10	
Level of Sig.			.01		.01	

swallowers, the numbers of the swallows in sequence, the group means and standard deviations for each swallow.

Findings: The mean voluntary muscle energy output of the normal swallowers was 0.81 millivolts per millimeter. The deviant group had a mean output of 1.20 millivolts. The orthodontic group had a mean output of 0.80 millivolts per millimeter with a standard deviation of 0.27. The difference between the means of the normal and deviant groups was significant beyond the .01 level.

The F-ratio for the significance of the difference between the means of the normal swallowing group and the orthodontic group was .00. The F-ratio for the significance of the difference between the means of the orthodontic group and the deviant swallowers was found to be 9.10 which is significant beyond the .01 level.

Figure 2 represents the differences in voluntary muscle energy output found per swallow for each group. Noticeable is the closeness of the curves for the normal and orthodontic groups. The graph clearly depicts the increased energy output by the deviant swallowers. Also noticeable is the drop in muscle energy output on the seventh swallow for each group.

FIG. 1 Group means, expressed in millivolts, of the voluntary muscle energy output of the Temporalis muscle expended by groups of normal, deviant and orthodontic swallowers for each of the twelve swallows.

The Suprahyoid Muscles

Measurements of the voluntary muscle energy output of the suprahyoid muscles were obtained on twelve swallows in four sets of swallows. Information concerning these measurements for the orthodontic group is presented in Table 3. For purposes of comparison similar data obtained for the normal and deviant swallowers from the public school group are also included. The Table identifies the groups of orthodontic, normal and deviant swallowers, the numbers of the swallows in sequence, the group means and standard deviations for each swallow.

Findings: The mean voluntary muscle energy output for the normal swallowers, was 2.39 millivolts per millimeter. Deviant swallowers had a mean muscle energy output of 2.74 millivolts. The difference between these two means was found to be significant at the .05 level.

FIG. 2 Group means, expressed in millivolts, of the voluntary muscle energy output of the Masseter muscle expended by groups of normal, deviant and orthodontic swallowers for each of twelve swallows.

Table 3. Electromyographic data: means and standard deviations, expressed in millivolts, of the voluntary muscle energy output of the Suprahyoid muscles expended by normal, deviant, and orthodontic swallowers during each of twelve swallows

No. of Swallow	Normal Group N = 12		Deviant Group N = 12		Ortho. Group N = 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	1.62	0.92	2.08	0.79	1.30	0.46
2	1.89	0.90	2.30	1.14	1.26	0.49
3	1.72	0.95	2.45	1.10	1.26	0.54
4	2.41	0.39	2.80	0.61	2.23	0.42
5	2.55	0.39	2.95	0.65	2.24	0.45
6	2.48	0.47	3.01	0.55	2.35	0.55
7	2.68	0.45	2.84	0.51	2.35	0.53
8	2.69	0.35	3.01	0.55	2.29	0.35
9	2.85	0.84	2.93	0.56	2.25	0.47
10	2.78	0.41	2.79	0.46	2.38	0.48
11	2.55	0.25	2.86	0.40	2.37	0.69
12	2.49	0.28	2.87	0.58	2.28	0.55
Grand Means and Stand. Dev.	2.39	0.40	2.74	0.59	2.05	0.43
F-Ratio:	Nor. vs. Ortho. = 3.64		Nor. vs. Dev. = 5.60		Dev. vs. Ortho. = 18.75	
Level of Sig.			.05		.005	

The orthodontic group was found to have a mean voluntary muscle energy output of 2.05 millivolts per millimeter with a standard deviation of .043. The F-ratio for the significance of the difference between the means of the normal and orthodontic group, 2.05 and the deviant group, 2.74 was 19.75 and was significant at the .005 level.

Figure 3 represents the difference in voluntary muscle energy output found per swallow for each group. Noticeable is the somewhat parallel muscle output of the three groups.

The Infrahyoid Muscles

Measurements of the voluntary muscle energy output of the infrahyoid muscles were obtained on twelve swallows in four sets of swallows. Information concerning these measurements for the orthodontic group is presented in Table 4. For purposes of comparison, similar data obtained for the normal and deviant swallowers from the public school group are also included. The Table identifies the numbers of swallows in sequence, the group means and standard deviations for each swallow.

Findings: The mean voluntary muscle energy output of the normal swallowers, was 1.62 millivolts per millimeter. The deviant swallowers had a mean energy output of 2.00 millivolts per millimeter. The F-ratio for the significance of the difference between these two means was found to be 79.32 significant beyond the .005 level.

The orthodontic group had a mean voluntary muscle energy output of 1.20 millivolts per millimeter with a standard deviation of 0.84. An analysis of variance to test the sig-

FIG. 3 Group means, expressed in millivolts, of the voluntary muscle energy output of the Suprahyoid muscles expended by groups of normal, deviant and orthodontic swallowers for each of twelve swallows.

Table 4. Electromyographic data: means and standard deviations, expressed millivolts, of the voluntary muscle energy output of the Infrahyoid muscles expended by normal, deviant, and orthodontic swallows during each of twelve swallows

No. of Swallow	Normal Group N = 12		Deviant Group N = 12		Ortho. Group N = 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	1.64	0.81	1.96	0.89	1.18	0.43
2	1.61	0.80	2.14	1.02	1.03	0.38
3	1.62	0.91	2.23	0.91	1.16	0.41
4	1.52	0.88	1.80	0.78	1.19	0.42
5	1.55	0.76	1.97	1.00	1.29	0.53
6	1.81	1.00	2.08	0.87	1.24	0.61
7	1.53	0.71	1.83	0.76	1.16	0.56
8	1.64	0.93	2.06	0.75	1.27	0.63
9	1.67	0.99	2.00	0.96	1.18	0.61
10	1.69	0.85	1.95	0.80	1.16	0.55
11	1.54	0.79	1.98	0.78	1.31	0.64
12	1.60	0.90	1.98	0.89	1.19	0.55
Grand Means and Stand. Dev.	1.62	0.79	2.00	0.84	1.20	0.50
F-Ratio:	Nor. vs. Ortho. = 168.01		Nor. vs. Dev. = 79.32		Dev. vs. Ortho. = 385.96	
Level of Sig.	.005		.005		.005	

nificance of the difference between this means and the means of the normal and deviant swallows revealed: normal swallows versus orthodontic swallows, an F-ratio of 168.01, significant beyond the .005 level; orthodontic versus deviant swallows, and F-ratio of 385.96 significant beyond the .005 level. Although all means were significantly different, it is noted that the difference between the orthodontic and normal groups was not smaller than was the difference between the normal and deviant groups. The greatest difference was between the orthodontic and deviant swallows.

The preceding would appear to indicate that the deviant swallows in this study used significantly more infrahyoid voluntary muscle activity during the act of swallowing than did the normal or orthodontic swallows.

Figure 4 represents the difference between the three groups. The graphs are parallel with some-what the same contour from swallow to swallow.

The Orbicularis Oris Muscle

Measurements of the voluntary muscle energy output of the orbicularis oris muscle were obtained for six swallows in two sets of three swallows for each child in each group. Information concerning these measurements is presented in Table 5. For purpose of comparison similar data obtained for the normal and deviant swallows from the public school group are included. The table identifies the groups of orthodontic, normal and deviant swallows, the numbers of the swallows in sequence, the group means and standard deviations for each swallow.

Findings: The mean voluntary muscle energy output for the normal swallows was 1.43 millivolts per millimeter. The mean output for the deviant swallows was found to

be 2.19 millivolts per millimeter. The F-ratio for the significance of the difference between the means of the normal and deviant swallowers was found to be 55.19 which is significant beyond the .005 level.

The orthodontic swallowers had a mean voluntary muscle energy output of 1.48 millivolts per millimeter with a standard deviation of 0.23. An analysis of variance to an F-ratio of 71.59, which is significant beyond the .005 level.

The preceding would appear to indicate that the deviant swallowers used significantly more orbicularis oris muscle activity than did the normal and orthodontic swallowers.

Figure 5 indicates the difference in voluntary muscle energy output found per swallow per group. Of note is the closeness and overlapping of the curves for the normal and orth-

FIG. 4 Group means, expressed in millivolts, of the voluntary muscle energy output of the Infrahyoid muscles expended by groups of normal, deviant and orthodontic swallowers for each of twelve swallows.

odontic swallowers while the curve for the deviant group is considerably above the curves of the other two groups. The graphic representation of the muscle energy output indicates that the deviant group used more orbicularis oris function during the act of swallowing than did the normal and orthodontic groups.

Suggested Temporal Signs of Deviant and Normal Swallowing Observed in the Electromyographic Tracings

Observation and analysis of the electromyographic tracings of the normal and deviant swallowers in this study appeared to suggest certain characteristic patterns. All records were analyzed concerning phase relationships between muscles and muscle groups during swallowing.

Electromyographic tracings of normal swallowers appeared to reveal that:

1. For all subjects suprahyoid and infrahyoid activity occurred simultaneously at the moment of peak activity in the swallowing act.

FIG. 5 Group means, expressed in millivolts, of the voluntary muscle energy output of the Orbicularis oris muscle expended by groups of normal, deviant and orthodontic swallowers for each of six swallows.

Table 5. Electromyograph data: means and standard deviations, expressed in millivolts, of the voluntary muscle energy output of the Orbicularis oris muscle expended by normal, deviant, and orthodontic swallows during each of six swallows

No. of Swallow	Normal Group N = 12		Deviant Group N = 12		Ortho. Group N = 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	1.46	0.72	2.26	1.13	1.66	0.23
2	1.28	0.75	2.34	1.02	1.44	0.34
3	1.37	0.68	2.31	1.12	1.63	0.37
4	1.71	1.09	1.95	0.82	1.33	1.39
5	1.60	1.14	2.12	1.01	1.44	0.30
6	1.14	0.56	2.18	1.05	1.29	0.32
Grand Means and Stand. Dev.	1.43	0.72	2.19	0.94	1.48	0.23
F-Ratio:	Nor. vs. Ortho. = 0.13		Nor. vs. Dev. = 55.19		Dev. vs. Ortho. = 71.56	
Level of Sig.			.005		.005	

2. Temporalis and masseter contraction appeared to occur just prior to the swallow. The contraction was not always sufficient intensity to record. In all cases where there was contraction, it always occurred just before the peak activity of the supra- and infrahyoid muscle activity.
3. In none of the normal swallows were there indications of temporalis or masseter contraction following the peak activity which indicated that the swallow had occurred.
4. Activity of the orbicularis oris muscle occurred ahead of the peak activity of the supra- and infrahyoids and then dropped off.
5. Normal swallows had much cleaner or clear-cut tracings, indicating less build-up of muscle activity prior to the swallow. The tracings appeared to indicate a clean approach to swallow activity, a clear-cut swallow and less superfluous muscle activity after the swallow.

The electromyographic tracings of the deviant swallows appeared to reveal that:

1. In the majority of cases, (ten of twelve) suprahyoid and infrahyoid peak activity was not simultaneous. There appeared to be suprahyoid contraction prior to the swallow which then decreased and then peaked again during the swallow. There appeared to be considerable "getting-ready-to-swallow" activity in these muscle groups. Suprahyoid activity appeared to occur just prior to infrahyoid activity during the actual swallow.
2. The masseter muscle appeared to contract prior to suprahyoid and infrahyoid peak activity and then declined in activity. It also appeared that the temporalis and masseter tended to contract at or near the end of the swallow. At times it appeared that the temporalis contracted after the suprahyoids had been activated relative to the swallow.

3. Deviant swallowers had electromyographs which were full of excessive activity. This activity appeared to occur both before and after the swallow. The patterns were not as clear-cut or decisive as those of normal swallowers.

FIG. 6 Electromyographic tracings (A) and integrated muscle energy output (B) for selected muscles involved in swallowing, for a normal swallower, during a sequence of three swallows, reading right to left.

FIG. 7 Electromyographic tracings (A) and integrated muscle energy output (B) for selected muscles involved in swallowing, for a deviant swallower, during a sequence of three swallows, reading right to left.

FIG. 8 Electromyographic tracings (A) and integrated muscle energy output (B) for selected muscles involved in swallowing, for an orthodontic swallower, during a sequence of three swallows, reading right to left.

Analysis of Electromyographic Tracings

The results of an analysis of the electromyographic tracings of the orthodontic swallowers, and comparisons made with the normal swallowers, revealed that the temporal patterns of the normal and orthodontic swallowers were remarkably similar for all muscles. This is in stark contrast to the dissimilarity in temporal patterns between the normal and deviant swallowers as reported earlier.

Summary

The preceding comparisons of electromyographic data concerning voluntary muscle energy output and analysis of electromyographic tracings would suggest that children diagnosed as deviant tongue-thrust swallowers, given the therapy outlined in this study and then diagnosed as having achieved normal swallowing, present electromyographic data and tracings that resemble normal swallowers. The major difference between the normal and orthodontic swallowers appears to be that orthodontic swallowers reflect better physiological economy. The orthodontic swallowers appear to be more efficient swallowers, expending less muscle energy output as do individuals trained in a particular muscle behavior. This can be considered as constituting validation of the empirical post-therapy judgments on the "corrected" swallowing made by the investigator.

REFERENCES

1. Andrews, R.G., Tongue Thrusting. *J. So. Calif. State Den. Assoc.*, **28**: 47-53, 1960.
2. Barclay, A.E., The Normal Mechanism of Swallowing. *British J. Radiology*, **3**: 534-545, 1930.
3. Basmajian, J.V., *Muscles Alive*. Baltimore: Williams and Wilkins, 1967.
4. Crosby, E.C., Humphrey, T., and Lauer, E.W., *Correlative Anatomy of the Nervous System*. New York: Macmillan Co., 1962.
5. Field, J., Magoun, H.W., and Hall, V.E., *Handbook of Neurophysiology*, Vol. II. Washington, D. C.: Amer. Physiological Soc., 1960.
6. Fletcher, S.G., Casteel, R.L., and Bradley, D.P., Tongue-thrust Swallowing, Speech Articulation, and Age. *J. Speech and Hearing Dis.*, **26**: 201-208, 1961.
7. Gwynne-Evans, E., An analysis of the Orofacial Structures with Special Reference to Muscle Behavior and Dental Alignment. *Speech*, **16**: 36, 1952 with deletions in *Amer. J. Orthodontics*, **40**: 715-720, 1954.
8. Lockhart, R.D., Hamilton, H.F., and Fyfe, F.W., *Anatomy of the Human Body*. Philadelphia: J. B. Lippincott Co., 1960.
9. *Macleod's Physiology in Modern Medicine*. Bard, P., (Ed.) St. Louis: The C. V. Mosby Co., 1941.
10. Stepovich, M.L., A Cephalometric Positional Study of the Hyoid Bone. *Amer. J. Orthodontics*, **51**: 882-899, 1965.
11. Whillis, T.W., Movements of the Tongue in Deglutition. *Tr. Brit. Soc. Study Orthodontics*, 121, 1946.