Tongue-thrust and the Stability of Overjet Correction

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Long-term study of incidence of tongue-thrust from age 4 to 18 finds the dysfunction disappearing in some individuals and appearing in others. A small study of the effect of tongue-thrust therapy on stability of overjet correction suggests a beneficial effect.

KEY WORDS: • MALOCCLUSION • MOUTH BREATHING • OVERJET • • TONGUE • RELAPSE •

Uncertainty still exists over some of the fundamental relationships between tongue function and malocclusion. These include the effects of oral behaviors such as tongue-thrust, habitual mouth-breathing, and sucking habits — and the changes in those dysfunctions with maturation.

UHDE (1981) examined 72 orthodontically-treated patients a minimum of 12 years after treatment to evaluate treatment and posttreatment changes in occlusion and evaluate their relationship to the type of original malocclusion and to therapeutic extraction. Uhde found a tendency for overjet, overbite, maxillary and mandibular arch widths, and maxillary and mandibular arch crowding to return toward their pretreatment values during the posttreatment period, reporting "unacceptable" occlusions in half of the subjects after 12 years. These tendencies toward relapse were not statistically related to the type of original malocclusion or to extraction.

One of the many factors suspected of contributing to the tendency of teeth to return to their pretreatment positions is tongue-thrust. Its frequent co-occurrence with malocclusion is recognized by most orthodontists. Whether it is more prudent to ignore it or to pursue some kind of treatment for its elimination is not agreed upon so readily.

In view of the controversial nature of tongue-thrust and tongue-thrust therapy, it seems worthwhile to provide a somewhat more extensive review of the literature than usual. The first segment of the review will cover relationships between oral behavior and orofacial form, the second will review studies of incidence and maturation, and the third will address the effectiveness of tongue-thrust therapy.

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Oral behavior and orofacial form

Research with human subjects

RIX (1946) studied 93 children between the ages of 7 and 12 years. Teeth-apart swallows were present in 27 of the 93 subjects. Deviant occlusions were found in 81% of those 27, while the incidence was only 36% among the remaining 66 subjects who swallowed with their teeth together.

RAY AND SANTOS (1954) examined 32 subjects with periodontal disease. The mean age was 38.6 years. All demonstrated a tongue-thrust, leading the authors to postulate a contribution of tongue-thrust to periodontal disease.

ROGERS (1961) found the incidence of tongue-thrust to be higher than normal in patients with malocclusions.

WERLICH (1962) studied 640 children, segregated into age groups averaging 6.6, 11.5, and 17.4 years. Prevalence of tongue-thrust was 30.4% in those with class II, division 1 malocclusion, 50.7% in openbites, and 98.5% in posterior crossbites. The incidence was 68.2% in the youngest group, and 47.6% in the middle age group.

NEFF (1963) examined eleven orthodontic patients, of whom six were tongue-thrusters. Those six tongue-thrusters swallowed an average of 37 times an hour, compared to 61 times for the non-thrusting subjects. Neff hypothesized that stronger tongue pressures in tongue-thrusters may be offset by less frequent swallowing.

SUBTELNY (1970) studied forty subjects, ten in each of four groups. Group I consisted of normals, groups 2 and 3 the corresponding Angle classes of malocclusion, and Group 4 openbites. Subtelny found tongue-thrust to not be a consistent syndrome, although a low, forward tongue position was common in all groups. In the absence of evidence supporting a cause-effect relationship, it was concluded that tongue function adapts to form.

MILNE AND CLEALL (1970) investigated 22 subjects with normal occlusion and normal swallows. Three incisor dentitional stages were represented: deciduous dentition, mixed dentition, and permanent dentition. The findings indicated a slight tendency for the tongue to be forward in stage two (mixed dentition), but this was not statistically significant. It was concluded that forward movements of the tongue during the stage when some teeth are missing should not be considered permanent.

PROFFIT (1972) cites evidence from transducer measurements indicating that maximum lingual pressures outweigh maximum labial pressures in subjects with normal occlusion.

HANSON AND COHEN (1973) conducted a longitudinal study whereby subjects were seen every ten months from age 4.9 through age 8.2 years. Retention of tongue-thrust through this age period correlated positively with a narrow palatal arch, greater palatal height, more mouth breathing, more overjet, more upper respiratory system allergies, more dentalized speech sounds, and more mentalis activity during swallowing.

MITANI (1976) studied a pair of identical twins in whom unilateral mandibular hyperplasia was found to be associated with lateral tongue-thrusting and posterior openbite. He concluded that the lateral openbite was maintained by the tongue-thrust.

FREELAND (1979) studied thirty subjects with a mean age of 9 years. Eighteen had been treated orthodontically, twelve were not. It was found that it was possible to differentiate those with normal occlusions on the basis of orofacial muscle behavior. Masseter activity was greater in

those with normal occlusion. Order of muscle activity during swallowing and chewing was consistent in subjects with normal occlusion, and highly variable in subjects with class II and class III malocclusions.

LOWE AND JOHNSTON (1979) examined twenty-four adult subjects, with findings indicating "enhanced genioglossus muscle activity together with an observed tongue protrusion in response to jaw opening in subjects with anterior open bite." LOWE (1980) examined the same 24 subjects and found 18 with no openbite but demonstrating other occlusal abnormalities of overjet, overbite, and individual tooth malpositions. The 6 openbites ranged from 0.5mm to 6.0mm. Low values for genioglossus muscle activity correlated positively with openbites, undererupted maxillary and mandibular incisors, and low total face heights. A strong relationship was found between tongue and jaw muscle activity and facial morphology.

DWORKIN AND CULATTA (1980) studied the relationship of maximum protrusive tongue strength to tongue-thrust, openbite, and articulation. The subjects consisted of two experimental groups of 35 children with normal speech and 21 children with frontal lisping, anterior tongue-thrusting, and openbite malocclusion. A control group of 85 children demonstrated normal speech and occlusion and did not thrust their tongues during swallowing. No significant differences in maximum tongue strength were found among the groups, suggesting that tongue-strengthening exercises may be superfluous.

WOOD (1980) compared the relationships between lip and tongue pressures and head position. Anterior lingual resting pressures were found to be significantly lower from head flexion to natural posture to extension. Upright incisors were observed in persons with extended head posture, suggesting that they may be due to differences in lingual pressures. Resting tongue pressures against lower anterior teeth were greater than labial resting pressures against teeth with natural head position.

LAMBERTON ET AL. (1980) compared 32 Asian dental students (mean age 22) with bimaxillary protrusion (interincisal angle less than 124°) with 43 of their peers who had interincisal angles of 124° or more. Fifteen (47%) of the 32 were mouth breathers, with habitual open-mouth postures. There were no mouth breathers among the 43 with higher interincisal angles. Abnormal lip and tongue habits were more common in the group with bimaxillary protrusions. Nine (28%) of the 32 appeared to have excessive tongue volume.

LARSSON AND KONNERMAN (1981) studied finger sucking and anterior openbite in 9, 11, and 13yr-old children. The clinical crown length among children in finger sucking groups was consistently greater than in control groups.

MODEER ET AL. (1982) studied sucking habits and posterior crossbite in 588 four-year-olds in Sweden. Forty-eight percent (48%) had some sort of sucking habit, dummy (pacifier) sucking being the most prevalent. Prevalence of normal buccolingual occlusion steadily decreased in cases where sucking habits persisted. An increase in the incidence of unilateral crossbite was most pronounced in children who persisted with sucking habits beyond the age of two years. Variable intensity of sucking habits was also significantly correlated with occurrence of unilateral crossbite.

LOUS AND OLESEN (1982) studied various types of headaches and oral functions. Subjects were 38 patients with chronic headaches and 25 without headaches. Elevated tongue pressures were signifi-

cantly more frequent in the headache group.

BRESOLIN ET AL. (1983) evaluated 45 subjects, ages 6 to 12 years. Thirty (67%) were chronic allergic mouth breathers, 15 (33%) nose breathers. The mouth breathers demonstrated significantly larger upper anterior facial height and total anterior facial height, higher mandibular plane angle and gonial angle, retrognathia, greater palatal height, greater overjet, narrower maxillary intermolar width, and higher prevalence of posterior crossbite.

Animal Research

NEGRI AND CROCE (1965) performed total glossectomies on ten rats. Three months after surgery, the diameters of both jaws in the experimental rats were smaller than those of the ten control rats.

In 1973, the first of a series of studies on rhesus monkeys was reported. HARVOLD ET AL. (1973) inserted acrylic blocks in the posterior palates of five animals, and a matching group remained untreated. All the experimental animals developed openbites during the nine months of the experiment, and experienced changes in the width of the dental arch.

In 1981, HARVOLD ET AL., induced nasal obstruction in 21 rhesus monkeys, and compared them with 21 untreated controls. The animals adapted in different ways. Typical resulting behaviors were an open-mouth posture, a protruding tongue, and gradually some type of malocclusion. Attempts to maintain an oral airway were associated with increased tonic activity and rhythmic movements in the muscles of the face and tongue and in those controlling the position of the mandible. Commonly, the mandibular arch narrowed and the length of the maxillary arch decreased. The tongue shape changed and an anterior crossbite developed.

MILLER ET AL. (1982) found that sequential neuromotor changes occurred in rhesus monkeys during initial adaptation to oral respiration. In the control group of nasal breathers, no significant trend in the nature of EMG discharge was observed. In the experimentals, effective means for increasing the anterior opening included rhythmic or sustained lowering of the mandible and tongue, and raising of the upper lip. A significant number of muscles that depress the mandible, protrude the tongue, alter the shape of the tongue, and raise the upper lip became rhythmically active within the first month of adaptation to oral respiration. The genioglossus and dorsal fibers of the tongue were also sometimes tonically recruited.

Tongue-thrust incidence and maturation

A wide range of incidence of tongue-thrust is reported in the literature, probably due to differing definitions.

TULLEY (1961) found a 2.7% incidence of tongue-thrusting. BELL AND HALE (1963) found 74% of children in grades 1 though 3 to be tongue-thrusting. In children ages 2 to 13 years, LEECH (1958) found 215 (43%) of 500 to be tongue-thrusting.

Incidence appears to decline with age, beginning sometime in the first four years. COUNIHAN AND LEWIS (1965) observed 294 newborns and found 286 (97.2%) to be demonstrating some form of tongue-thrust behavior. HANSON AND COHEN (1973) reported an incidence of 58% among a different sample of 225 four-year-olds.

Three studies which report results by age groups essentially agree with respect to incidence and to a decline in incidence up to about eight years of age. They disagree on incidence patterns in later years.

Two of the three studies are cross-sectional in nature (WERLICH, ET AL., 1962, AND FLETCHER, ET AL. 1961), and one (HANSON AND ANDRIANOPOULOS, 1982) provides longitudinal data. Table 1 compares the findings of these three studies.

All three studies agree on a decrease in prevalence through the mixed dentition; however, Hanson-Andrianopoulos found an increase at 17-18yrs. Fletcher's criteria constituted a syndrome, including no masseter activity during swallowing. Werlich's subjects' lips were parted with a tongue blade during testing. Hanson and Andrianopoulos parted the lips after the swallow had begun, and recorded thrusting of the tongue without regard for associated behaviors. Earlier research has found that associated behaviors are not consistently related to tongue-thrust swallows (HANSON AND COHEN, 1973).

Effectiveness of therapy

A summary of studies on the effectiveness of therapy for tongue-thrust is shown in Table 2. Following is a brief explanation of the individual studies.

ROBSON (1963) followed 666 subjects who had completed therapy for tongue-thrust from 6 to 31 months previously. Five hundred twenty (78.1%) retained a corrected swallowing pattern.

BARRETT AND VON DEDENROTH (1967) reported success in maintaining corrected habits in 25 patients 1 to 3 years after treatment by hypnotherapy.

STANSELL (1969) studied three groups of 18 subjects each, all of whom had a tongue-thrust, a lisp and an overjet. Group I received swallowing therapy, group II received speech therapy, and group III received no therapy of any kind. Stansell found that speech training alone decreased overjets, and that tongue-thrust therapy prevented an increase in overjet. Overjets increased in several untreated patients.

CHRISTOFFERSON (1970) evaluated swallows of 25 subjects, all of whom had completed therapy at least five years previously. Twenty three (92%) swallowed correctly on voluntary swallows, and 21 (84%) on off-guard swallows.

SUBTELNY (1970) observed five subjects with "abnormal swallows." Not all of the five were tongue-thrusting; however, all subjects received the same therapy for tongue-thrust. Abnormal patterns persisted after completion of therapy.

CASE (1975) examined 40 children with tongue-thrust and provided therapy for half of them. Posttherapy palatograms were presented to judges in random order, and they were able to differentiate the swallowing patterns of the treated group consistently and reliably.

OVERSTAKE (1975) used electromyography to compare 12 normal swallowers with 12 tongue-thrusters and 6 corrected tongue-thrusters. Characteristics of tongue-thrust patterns were not found on the EMG's of the corrected thrusters,

Table 1

Tongue Thrust Incidence
Reported by Age

	6 7yrs	8yrs	11 12yrs	17 18yrs
Fletcher et al. (1961)	51.3%	38.5%	—	21.0%
Werlich et al. (1962)	37.3%	—	27.6%	26.4%
Hanson and Andrianopoulos (1980)	51.7%	—	38.9%	41.4%

whose patterns closely matched those of the normal swallowers.

TORONTO (1975) studied 50 treated cases in a manner similar to that of CHRISTOFFERSON (1970). Two subjects (4%) placed the tongue interdentally during swallowing, and 12 (24%) contacted the lingual surfaces of the anterior teeth. The remaining 72% swallowed normally. The success rate was 72% to 96%.

COOPER (1977) found both oral myofunctional therapy and cribs to be effective in correcting tongue-thrust. In two experimental groups, "the severity of the angular protrusion" of the maxillary incisors decreased, and it increased in a group of controls.

CHRISTENSEN AND HANSON (1981) studied five 6yr-old elementary school children with tongue-thrust and /s/ sound defects. They received 14 weeks of articulation therapy. Five matching subjects received the same total therapy time, with part of that time devoted to oral myofunctional therapy. Children in both groups made equal progress on /s/ remediation, and those who received oral myofunctional therapy also corrected their tongue-thrust.

OHNO ET AL. (1981) presented twelve cases as evidence that therapy for tongue-thrust is an effective adjunct in correcting malocclusion.

A single-subject study was reported by YOUNG AND VOGEL (1983) in which the proper resting posture of the tongue was established by the use of cueing and positive reinforcement in a 21yr-old college student. Follow-up data obtained 30 months after therapy indicated that positive effects of the training were still retained.

Table 2

Overview of Reports on the Effectiveness of Treatment for Tongue Thrust

	Controls			Length of Study			
				<3 months		>3 months	
	Normal Subjects	Same Subjects	Similar Thrusters	Effective? Yes	No	Effective? Yes	No
Robson (1963)		X				X	
Barrett and von Dedenroth (1967)		X				X	
Stansell (1969)			X			X	
Christofferson (1970)		X				X	
Subtelny (1970)		X			X		
Case (1975)			X	X			
Overstake (1975)	X					X	
Toronto (1975)		X				X	
Cooper (1977)			X	X			
Christensen and Hanson (1981)			X	X			
Ohno, Yogosawa, and Nakamura (1981)			X	X			
Totals	1	5	5	4	1	6	0

Summary of Research Reports

The literature on research with human subjects gives evidence of relationships between —

- Malocclusion (including bimaxillary protrusion, openbite, and overjet), mouth breathing, and tongue-thrust.
- Orofacial morphology and tongue-thrust.
- Sucking habits and openbite and crossbite.
- Tongue-thrust and headaches.

— but no relationship between tongue strength and malocclusion has been reported.

Animal research shows an intimate reciprocal relationship between oral form and function.

Ten of the eleven reported studies found therapy to be effective. All six of the long-term studies produced results supportive of therapy (Table 2).

This report presents the results of two separate studies designed to investigate the four questions posed in the introduction. The first study is directed toward the second question, "Does maturation eliminate or reduce tongue-thrusting during late childhood and adolescence?" The second investigates interrelationships between tongue-thrust and mouth breathing, along with the effects of orthodontic treatment and tongue-thrust therapy on future tongue-thrust activity.

Project 1

Changes in tongue-thrust incidence at age 18

This is the final stage of a 14-year longitudinal study.

In 1967, a team of investigators representing the fields of speech pathology and dentistry began collecting data on a group of 225 randomly selected children whose mean age was four years, nine months.

The initial purpose of this longitudinal research was to determine which anatomic and behavioral factors might be associated with the retention of tongue-thrusting through the mixed dentition period of development. The children were seen at about ten-month intervals until they were eight years old. By that time, 178 (79%) were still available for study. At the 12yr-old stage 92 (41%) of the subjects were located, and 61 (27%) were available when they were 18 years old.

The researchers expected a steady decline in the incidence from early childhood through adolescence. This decline did obtain from ages 4 through 8, but an unexpected reversal appeared at age 12, when 45 (48.9%) of the 92 subjects seen were found to be tongue-thrusting (HANSON AND HANSON, 1975).

An examination of the data from the 92 subjects disclosed that 10 of the tongue-thrusters might be termed transitional, in that they were protruding the tongue into spaces recently occupied by deciduous teeth. Thirty-five of the remainder of the sample (38% of the 92) were classified as definite tongue-thrusters at age 12. Although this is an increase over the 35% incidence at age 8, attrition had reduced the study group from 178 to 92, so the change may not be— significant.

Subjects and Procedures

Of the 61 subjects located for study at age 18, 28 were males and 33 females. Ages ranged from 17 years, nine months, to 18 years, 9 months.

A brief questionnaire concerning dental history and mouth- or nose-breathing habits was filled out by each subject, and

swallows of a wafer, water, and saliva were observed by three experienced oral myofunctional therapists. The therapists were unacquainted with the objectives of the research, and had no other connection with the research project. Independent judgments were made by all three judges of the same swallows. Whenever a judge was uncertain, another swallow of the same medium was requested, until all were satisfied with the basis for their judgment.

Measurements for overjet and openbite were made directly from the dental casts. The upper and lower dental casts were occluded by means of a wax impression of the subject's bite at the time of examination. To assure consistency, the same criteria for measuring overjet and openbite were followed as had been followed in earlier stages of the longitudinal research.

The overjet was recorded as the mean of the difference (in millimeters) between the two greatest distances on the occlusal plane between the most anterior lingual points on the maxillary central or lateral incisors and the two corresponding points on the labial surface of the mandibular incisors. Openbite was determined by measurement of the vertical distance between the maxillary central or lateral incisors with molars in occlusion.

Tongue-thrust was defined as any tongue contact with the lingual surfaces of any (upper or lower) incisors or cuspids, or protrusion of the tongue between upper and lower incisors or cuspids, in swallowing. It was recorded on the 0-1-2 scale used in the original research begun in 1967, with "0" indicating no contact with any anterior teeth, "1" indicating contact with the lingual surface of any of the anterior teeth, and "2" indicating tongue protrusion over the incisal edge of one or more anterior teeth. For purposes of data analysis, those having a "2" rating with at least two of the three test media (solids, liquids, saliva) were judged to be tongue-thrusting.

— Results —

Among the sixty-one 18yr-olds who were located and agreed to be examined in the last phase (14 years after the initial examination), 26 (42.6%) were diagnosed as tongue-thrusters. Tongue-thrust appears to have not decreased through adolescence in the subjects who remained in this longitudinal study. The pattern of incidence from age 4 to age 18 was a decrease to 35% at age 8, and then a gradual increase to 38% at 12, and 42.6% at age 18.

Many developmental variations in swallowing patterns were found in the 61 individual subjects studied at age 18.

- Only 4 of the 26 tongue-thrusting at 18 years had also been diagnosed as tongue-thrusters at both 4 and 8 years of age.
- 12 of the tongue-thrusters identified at age 18 had also been tongue-thrusting at age 4.
- 18 of the 61 had been tongue-thrusting at the age of four, but were swallowing normally at age 18.
- 18 of the 61 had been tongue-thrusting at the age of eight, of whom 10 were still tongue-thrusting at age 18.
- Of the 26 who were tongue-thrusting at age 18, 14 had demonstrated normal patterns at age 4.
- 13 of the tongue-thrusters identified at age 18 had swallowed normally at both 4 and 8 years.
- Only 7 of the 61 were classified as normal swallowers at ages 4, 12, and 18.

— Discussion —

According to the results of this longitudinal study, an orthodontist who sees an eight-year-old patient with an overjet, with or without a tongue-thrust, has little information on which to base any prediction concerning the development or retention of a tongue-thrust as the patient matures.

Interestingly, only one of the 61 eighteen-year-olds had a measurable openbite. This patient had not been found to be tongue-thrusting at 4, 8, or 18, and no tongue-thrust therapy was ever recommended or received. Dental casts taken at the 8yr-old visit show no openbite, but do show an overjet. This was corrected orthodontically, and a retainer has been used for the past 5½ years.

Twenty of the 61 subjects had received orthodontic treatment. Of the 41 who had not had orthodontic care, 17 (41.5%) were tongue-thrusting at 18 years. Of the 20 who did receive orthodontic treatment, nine (45%) were tongue-thrusting at 18. This shows no significant relationship between the incidence of tongue-thrust at 18 and prior orthodontic treatment.

Project 2

Tongue-thrust therapy and stability of corrected occlusion

This second project investigates relationships between overjet stability and therapy for tongue-thrust. The hypotheses tested were:

Hypothesis 1. Orthodontic treatment alone, without therapy for tongue-thrust, will eliminate tongue-thrust in class II patients.

Hypothesis 2. Patients who receive therapy for tongue-thrust prior to the initiation of orthodontic overjet reduction will retain correct tongue habits following the completion of the orthodontic correction.

Hypothesis 3. Patients who receive therapy for tongue-thrust will have less overjet relapse than those who receive no therapy for tongue-thrust.

Subjects

The therapy group consisted of seventeen subjects, 6 males and 11 females, all of whom had been classified by their orthodontists as having class II, Div. 1 malocclusions prior to orthodontic treatment, and all of whom had completed therapy for tongue-thrust. Subjects were randomly selected from tongue-thrust patient files at the University of Utah. Subjects' ages ranged from 16 to 30 years, with a mean age of 22.6 years.

The nontherapy group consisted of 17 subjects, 11 males and 6 females, all of whom had been classified by their orthodontists as having class II, Div. 1 malocclusions prior to orthodontic treatment. All subjects had worn fixed appliances and retainers, and had not worn an upper retainer for at least one year.

The subjects were chosen at random from the files of cooperating orthodontists in Salt Lake City, Utah. The presence or absence of tongue-thrust before or after orthodontic treatment was not a factor in the selection of subjects. Ages ranged from 18 to 30 years, with a mean age of 22.4yrs. Other data on these subjects are given in Table 3, which compares the therapy and nontherapy groups.

Procedures

The subjects completed a brief questionnaire and were examined for tongue behavior, including resting posture, speech, and swallowing food, saliva, and liquids. Judges were three experienced orofacial myologists who were not acquainted with the subjects. Judgments

were made independently, but on the same swallows. An abridged rating system was used, "0" indicating no tongue-thrust, "1" a tongue-thrust, with tongue-thrust defined as tongue contact on more than half of the lingual surface of any incisor or cuspid.

Orthodontic treatment records of each subject were examined for type of malocclusion, duration of orthodontic treatment (fixed appliances and retainer), and speech and/or oral habit therapy.

Pre- and post-orthodontic treatment casts and cephalographs were obtained from the orthodontist for each of the 34 subjects. In each case, the Angle classification of the malocclusion was determined by the orthodontist who had treated the patient.

New impressions were taken to record the present occlusion, and overjet was measured on pretreatment, posttreatment and new dental casts. Relapse of overjet was calculated as the difference between the posttreatment casts and the new casts.

Cephalometric analyses were not a part of the original research plan; the investigators had considered that a designation of class II by the referring orthodontist would suffice, and that measurements of overjet from dental casts would meet the objectives of the research. Following the completion of the study, a question was raised concerning skeletal subtypes of class II; whether the therapy and non-therapy groups might be comprised of differing proportions of subgroups which might bias the results of the research.

Accordingly, those cephalographs that could be located by the referring orthodontists were sent to a neutral, experienced orthodontic researcher* for a "blind" analysis to determine the skeletal type. He had no knowledge of any subject's group attachment (therapy or nontherapy).

The following variables were included in the statistical analysis:

- Pretreatment overjet
- Posttreatment overjet
- Present overjet
- Skeletal type
- Tongue-thrust
- Therapy for tongue-thrust
- Breathing pattern (predominantly nose, mouth, or both)

*Robert Mason, Duke University.

Table 3

Orthodontic Treatment Histories of Study Groups
(Time in Months)

	Tongue Therapy			No Tongue Therapy		
	min	mean	max	min	mean	max
Treatment time (mo)	18	24	48	8	28	54
Retainer time (mo)	5	23	84	12	32	96
Posttreatment period	18	79	156	12	81	120

— Results —

Three of the 17 therapy subjects (17.6%), and 12 of the 17 nontherapy subjects (70.6%), were found to be currently tongue-thrusting.

The mean relapse in overjet since the removal of appliances was 0.56mm for the therapy group and 1.94mm for those with no tongue-thrust therapy. With reference to present swallowing habits within each group, a mean overjet relapse of 1.0mm was found in the 3 therapy group subjects who were currently tongue-thrusting, and 0.46mm in the 14 who swallowed without a tongue-thrust. Among the nontherapy subjects, the mean overjet relapse was 2.0mm for the 12 tongue-thrusters and 1.8mm for the 5 with normal swallow.

The relationship between tongue-thrust therapy and the amount of relapse was found to be statistically significant ($r=.43$, $t=-2.71$, $p<.02$).

The combination of the two variables "tongue-thrust therapy" and "current tongue-thrust" was significantly related to the amount of relapse (multiple $r=.44$, $F[2,33]=3.74$, $p<.04$). The signs of the coefficients in the regression equation support the hypothesis that having tongue-thrust therapy and not currently tongue-thrusting are positively related to a smaller overjet relapse.

A third significant finding was that persons with different breathing patterns differed in the amount of overjet relapse. When the therapy and nontherapy groups were combined, those who were predominantly mouth-breathers were found to have greater relapse (mean 3.0mm) than those who breathed principally through their noses (mean 1.3mm). Those who reported breathing through both nose and mouth had a mean relapse of 0.12mm. While this relationship was statistically significant ($F[2.33]=5.42$; $p<.01$), clinical relevance is questionable in such a small sample.

A fourth finding was a significant difference in the present incidence of tongue-thrust between those who had received tongue-thrust therapy and those who had not (Fisher exact test probability .0049, two-tailed).

Cephalometric analysis of the available pre-orthodontic treatment radiographs of 28 subjects indicated that 12 (43%) exhibited retruded mandibles prior to orthodontic treatment, and six (21%) exhibited protruding maxillae. Five (18%) of the subjects were classified as marginal cases, in that cephalometric analysis indicated a class II profile without markedly protruding maxillae or retruded mandible. The remaining five subjects showed no Class II skeletal characteristics.

A comparison of independence or association was made between the class II malocclusion and tongue-thrust therapy to determine whether the tongue-thrust therapy group represented a different skeletal population than those who had received no tongue-thrust therapy. This showed no relation to history of tongue-thrust therapy ($\chi^2=.23$, $a=.05$; $\Phi=.09$).

A similar statistical comparison between overjet and tongue-thrust also indicated no association between the two variables. ($\chi^2=1.86$; $a=.05$, $\Phi=.26$). These findings indicate that the sample is unbiased.

With respect to hypothesis 1, that orthodontic therapy alone will eliminate tongue-thrust, 12 (71%) of 17 subjects with class II, Div. 1 malocclusions who received orthodontic treatment with no therapy for tongue-thrust were tongue-thrusting after treatment, compared to only 3 (18%) of the 17 who also had tongue-thrust therapy. The hypothesis is not supported by these findings, although the interpretation is clouded by the fact

that tongue-thrust was not assessed prior to treatment.

Hypothesis 2, that those with tongue-thrust therapy prior to orthodontic therapy will retain correct tongue function after treatment, is supported by the response of 14 (82%) of the sample of 17.

Hypothesis 3, that tongue-thrust therapy will reduce overjet relapse, is supported by the differences in overjet relapse.

— Discussion —

Subjects in the nontherapy group were limited to those whose orthodontists agreed to participate in the research. All participating orthodontists have frequently referred patients to the University of Utah for therapy. These nontherapy subjects were patients whom these orthodontists had not referred for therapy, presumably either because they saw no tongue-thrust problem, or because they saw a pattern that was too inconsistent or mild to warrant referral.

It is likely that those who did receive therapy were the more severe tongue-thrusters, while those not referred for therapy would be more likely to exhibit normal tongue behavior later. This did not prove to be the case.

Even though there is an intimate interrelationship between lip resting postures and breathing patterns, the difficulties of accurate assessment of breathing pattern made it impossible to assess this factor objectively in this study. Participation in a study on breathing calls the subject's attention to breathing and provides a reminder to try to breathe more through the nose. This may affect the naturalness of the breathing pattern, and may also bias responses to questions about the habitual mode of breathing. No data was available concerning the habitual manner of breathing prior to orthodontic treatment.

The authors recognize that the procedure of randomly selecting patients with class II, Division 1 malocclusions, without regard for skeletal subtypes, might have biased the study in favor of either the therapy or the nontherapy group. It is possible that one skeletal type might retain corrected overjet better than another.

With that in mind, all subjects for whom before- and after-treatment cephalographs were available were divided by an orthodontist on the basis of the pretreatment film into groups with favorable and unfavorable prognosis for stability of overjet correction. This was done without knowledge of placement in therapy or nontherapy groups. A statistical analysis found no relationship between these classifications and the stability of overjet correction.

Tongue-thrust and orthodontic treatment

Tongue-thrust may begin during orthodontic treatment, particularly when the treatment requires creation of temporary open spaces or interferences with intercuspation, or reduces tongue space. Such thrusting may be transitory or permanent.

Research has found that anything that restricts the space available to the tongue promotes tongue-thrust. If the tongue is against the upper teeth when they are in overjet, and the teeth are then moved posteriorly, they logically become more accessible to the tongue. There will also be less anteroposterior space available to the tongue. Tongue-teeth contact is thus facilitated as incisors are retracted, with possible activation of a latent tongue-thrust.

Therapy

This study demonstrates that the type of therapy administered at this particular

clinic was effective. Approaches vary a great deal, as do abilities of clinicians to motivate patients. The following brief comments describe the highlights of the approach used with these patients.

1 Most strengthening exercises are considered superfluous. The focus in therapy is on (1) the establishment of proper tongue and lip resting postures; (2) perceptual discrimination between correct and incorrect patterns; and (3) *movements* of tongue, lip and jaw in function.

2 Therapists use practice assignments that most closely resemble the actual functions they are trying to modify. The more remotely related an exercise is to an actual function, the less value it offers in retraining.

3 In the opinion of these investigators, success ultimately depends on modification of functional movement patterns, and that approximately equal time should be given to each of the three phases of therapy: (1) the retraining of movement patterns, (2) the generalization of those patterns, and (3) their maintenance. Abandonment of therapy after apparent success in phase 1 will leave little long-term benefit.

4 Therapy individualized to conform to the unique needs of the individual is much more effective than the common practice of applying the same program to every patient.

Significance of present findings

In terms of patient satisfaction and cosmetic and functional adequacy, the difference between the .56mm and 1.9mm average relapse of overjet can be significant.

Recommendations

This study reports the results of one type of therapy, administered by one clinician, to patients with one type of malocclusion. Much more research is still needed.

These findings, along with the earlier research reviewed in the first part of this article, indicate a need for serious consideration of the inclusion of a comprehensive course in orofacial behavioral disorders in orthodontic curricula.

These results should also encourage dentists to observe patients of all ages, and those in all stages of orthodontic treatment, for evidence of tongue-thrust.

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