Research Article

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Tongue Thrust and Malocclusion: A Longitudinal Study

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ABSTRACT

The closing phase of the only longitudinal study of tongue thrust, started in 1967 by Hanson and associates, is reported. Data were gathered over a period of 13½ years, starting with a group of 225 children with a mean age of 4 years, 9 months. Of this group, 61 were located and examined at or near age 18. The findings from this final evaluation are analyzed.

PHASE ONE

In 1967, a team consisting of five orthodontists, three speech pathologists, and a radiologist, began seeing a group of 225 randomly selected children (mean age: 4 years, 9 months) in order to examine some developmental interrelationships among dentition, speech, and oral-vegetative habits. The principle purpose of the longitudinal research they were initiating was to determine which anatomic and behavioral factors might be associated with the retention of tongue thrusting throughout the mixed dentition period of development. The researchers saw the children at nine to eleven month intervals until the subjects were eight years old, obtaining dental models, lateral head x-rays and cineradiographic films of swallowing, and making direct judgments of lingual function during speech and during eating, drinking, and saliva swallowing. At the end of the four years, 178 subjects remained in the research, and thousands of items of data had been collected. The results of that research were published in various orthodontic, dental, and speech pathology journals. (Barrett and Hanson, 1978; Hanson and Cohen, 1973.)

In answer to the principal question of the research, the following criteria are significantly and positively correlated with the retention of tongue thrust through the age of eight years:

1. A high, narrow palatal arch.

2. Lingual crossbite.
3. Mouth breathing.
4. Maxillary overjet.
5. Dentalization of speech sounds.
6. Allergies affecting the upper respiratory system.
7. Enlarged tonsils.

A second purpose of that research was to study incidence of tongue thrust longitudinally. The incidence, reported by mean ages of subjects at each age level was:

Four years, nine months:	57.9%
Five years, eight months:	43.8%
Six years, seven months:	51.7%
Seven years, five months:	35.4%
Eight years, two months:	35.0%

The decline in incidence had been expected. According to other studies, cross-sectional in nature rather than longitudinal, the decline could be expected to continue through adolescence and into adulthood.

PHASE TWO

When the subjects were twelve years old, they were again examined. Data from that phase of the research were published in the International Journal of Oral Myology in 1975 (Hanson and Hanson). At that time, 92 of the subjects were available for evaluation. Thirty-one of the 92 subjects (33.7%) were tongue thrusting at eight years, two months. Four years later, 22 of the 31 were still tongue thrusting, but an additional 23 who had swallowed normally at eight years were now tongue thrusting. Hence a total of 45 of the 92 twelve-year-olds (48.9%) were manifesting a definite tongue thrust. This represented an increase of 15.2% in incidence among the twelve-year-olds.

The investigators had expected a decline in incidence, rather than an in-

crease. Re-examining the data, they found that 23 of the 80 subjects who had received no orthodontic treatment manifested incomplete eruption, or absence, of one or both maxillary canines. Twenty-one of these children protruded the tongue into these spaces, which would soon be filled with fully-erupted teeth. They had been diagnosed, according to the authors' criteria for determining tongue thrust, as tongue thrusters. Ten of the 21 had otherwise normal occlusions. According to some writers, these might be termed "transitional thrusters." If we were to assume that was correct, in accordance with our wishes to give a very conservative interpretation to our findings, we would subtract those ten transitional thrusters from the total of 45, leaving 35 tongue thrusters among the 92 subjects (38.0%). The most conservative tabulation of data, therefore, would result in an increase in incidence of tongue thrust for these 92 subjects of 4.3% between the ages of eight and twelve years.

PHASE THREE

Six years later, when the subjects were 18 years old, or within three months of their eighteenth birthday, 61 were located and were examined once more. Twenty-six subjects were diagnosed as tongue thrusters. Now the incidence, using the conservative criteria for determining tongue thrust, was 42.6%. This was a 4.6% increase over the incidence at 12 years, and an 8.9% increase over the incidence found when the subjects were eight years old. Tongue thrust had not decreased through adolescence in subjects in this longitudinal study.

Longitudinal data were obtained on subjects from four years, nine months, to eighteen years of age. The pattern of incidence over that period of time was a decrease from 57.9% at the earliest age sampled, to 35.4% at eight

years, two months, then a fairly stable incidence, with some increase, over the next ten years.

Comparisons With Other Studies:

Though this is the only longitudinal study in the literature, three other studies examined incidence at various age levels concurrently. Each of the studies found a steady decline in incidence with increasing age. Each, however, used a different set of criteria for identifying tongue thrust. A comparison of the present study with those three, along with a description of the criteria of each for identifying tongue thrust follows:

Hanson and associates: Observed 61 subjects over a period of 13½ years. Found a decrease in tongue thrust from age four years, nine months to eight years, two months, then a slight increase through age eighteen.

Criteria: The tongue must protrude between the upper and lower teeth during the swallows of at least two of three media: solids, liquids, and saliva.

INCIDENCES	
Mean Age	Tongue Thrust
4-9	57.9%
8-2	35.0%
12-0	38.9%
18-0	42.6%

Andersen (1963): Observed 59 students in the first, sixth, and twelfth grades. Reported a relatively low incidence of tongue thrust, with a marked decline in incidence as age increased.

Criteria: Only those individuals with an anterior open bite were diagnosed as tongue thrusters. Tongue thrust was termed a syndrome.

INCIDENCES	
Mean Age	Tongue Thrust
6-4	21.3%
11-6	14.6%
17-4	9.0%

Werlich (1962): Observed 640 children, elementary through high school. Reported a moderate decline in tongue thrust as age increased.

Criteria: These were not clear in Werlich's report. The serious error in his procedure for determining presence of tongue thrust was to part the subject's lips with a tongue depressor prior to swallows.

INCIDENCE

Mean Age	Tongue Thrust
6-6	37.3%
11-5	27.6%
17-4	26.4%

Fletcher and associates (1961): Examined 1615 school-age children. Found a significant decrease in tongue thrust from age six to age sixteen.

Criteria: A syndrome of characteristics was necessary for a swallow to be diagnosed as a tongue thrust pattern. The following criteria were essential: (1) No masseter activity during swallow. (2) Extreme difficulty swallowing when labial seal was broken. (3) Tongue had to protrude beyond the edges of the incisors.

INCIDENCES	
Mean Age	Tongue Thrust
6	52.3%
8	38.5%
16	20.0%
18	21.0%

The four studies are compared in Figure 1.

Summary: All four studies found a

decrease in tongue thrust during the early elementary school years. Hanson's study found the trend reversed after the age of eight, and a slight increase continued through the age of eighteen. Important differences in diagnostic criteria were found among the studies. Hanson's earlier research had found that no consistent syndrome of diagnostic features could be found among children with tongue thrust. Characteristics which had been previously considered necessary for a tongue thrust to occur were found to be not always present in tongue thrusters, and often present in non-tongue thrusters. These included absence of contraction of the masseter muscle during swallowing, increased circumoral muscle contraction during swallows, and reduced gag reflex. Andersen's requirement of an open bite is unrealistic; only approximately nine per cent of the patients seen by Hanson and Barrett in their separate practices have an anterior open bite. Werlich's procedure of holding the lips apart with a tongue depressor prior to the swallow introduced an important artifact into his study. Finally, although cross-sectional studies do demonstrate developmental trends, they are not so precise as studies which follow a given group of children longitudinally.

Figure 1
FOUR INCIDENCE STUDIES OF TONGUE THRUST

Developmental Patterns in Individuals. Incidence figures refer to group data. One cannot assume that an increase or decrease of incidence of a given behavior in a group reflects that same directional change in each subject in the group. It is interesting to see what happened to the 61 individuals seen in this study at the age of eighteen years over the 13½ year period covered by the research. (Fig. 2)

At four years, nine months, 30 of these 61 children were tongue thrusting. Only 12 of these were tongue thrusting at eighteen years.

At eight years, two months, 18 were tongue thrusting. Of these, 10 were tongue thrusting at eighteen years.

Only 6 subjects were found to be tongue thrusting at both four years, nine months, and eight years, two months. Of these, 4 were tongue thrusting at eighteen years.

At four years, nine months, 32 of the 61 were not tongue thrusting. At eighteen, 13 of the 32 were not tongue thrusting.

At eight years, two months, 44 of the 61 were not tongue thrusting. At eighteen, 15 of the 44 were not tongue thrusting.

Twelve subjects were found to be not thrusting at both four years, nine months, and eight years, two months. At eighteen, 7 of the 20 were not thrusting.

Obviously, patterns of swallowing in individual subjects between the ages of eight and eighteen years are not nearly so stable nor predictable as are incidence figures obtained from the groups those subjects comprise. An orthodontist who sees an eight-year-old patient with a malocclusion and a tongue thrust has little information on which to base any judgment concerning the prognosis for retention or remission of tongue thrust. Even if the patient has no tongue thrust at eight years, he may develop one at some time during the next ten years.

Some of the 61 subjects did receive orthodontic treatment during the years covered by the research. All members of the research team were instructed to only examine the patients, not to advise them concerning treatment. It is likely, nevertheless, that the repeated visits to specialists whose procedures all centered on the teeth and tongue prompted an increase in attention of children and their parents to dental occlusion. Of the 61 subjects, a total of 20 had braces and/or retainers. Fifteen of the 20 had braces. Nine of the 20 were in retention at the time they were examined at eighteen years. Data which follows examine some findings

FIGURE 2
INCIDENCE OF TONGUE THRUST AT AGES 4-9, 8-2, 18 YEARS
(USING CONSERVATIVE DEFINITIONS OF TONGUE THRUST ONLY)

SUBJECTS WITH: TONGUE THRUST AT:	NUMBER OF SUBJECTS	
	TONGUE THRUST AT 18 YEARS	NO TONGUE THRUST AT 18 YEARS
4-9	12	18
8-2	10	8
4-9 AND 8-2	4	2
NO TONGUE THRUST AT:		
4-9	13	19
8-2	15	29
4-9 AND 8-2	7	13

(CATEGORIES ARE NOT MUTUALLY EXCLUSIVE)

concerning this orthodontically-treated group of 20 persons.

Orthodontic Work and Tongue Thrust. Figure 3 presents data pertaining to relationships between orthodontic work and tongue thrust. Of the 15 subjects who had braces, 7 were not found to be tongue thrusting either at eight or at eighteen years. Only 2 were tongue thrusting at both ages. Four were not tongue thrusting at eight, but were doing so at eighteen. Two were tongue thrusting at eight, but not at eighteen. Both of these had received therapy for tongue thrust.

Of the 5 who wore retainers but no braces, 2 were tongue thrusting at both eight and eighteen years, 2 were not tongue thrusting at either age, and 1 was not thrusting at eight years, but was thrusting at eighteen. Five of the 9 were not tongue thrusting at eight

years, prior to orthodontic treatment. Only 2 of 6 who were tongue thrusting at eight years stopped doing so during the ten-year period, and both of these subjects had tongue thrust therapy.

As confusing and seemingly unpatterned as these data are, one finding seems clear: Tongue thrust in this group did not consistently yield to normal patterns as a result of orthodontic treatment.

Orthodontic Work and Occlusion. Since 9 of the 20 who received orthodontic treatment are still in retention, meaningful data on the effectiveness of orthodontics in permanently correcting occlusion are not available at this time. The orthodontic patients we saw appeared to be progressing satisfactorily. There was one exception: the one subject of the 61 who had any measurable open bite.

FIGURE 3
ORTHODONTIC WORK AND TONGUE THRUST

ORTHO WORK:	T TH AT 8-2, NONE AT 18	T TH AT 8-2, T TH AT 18	NO T TH AT 8-2, NONE AT 18	NO T TH AT 8-2, T TH AT 18	TOTAL
BRACES	2 *	2	7	4	15
RETAINERS	0	2	2	1	5
TOTALS	2	4	9	5	20

* BOTH RECEIVED THERAPY FOR TONGUE THRUST

The Case of the Lone Open Biter. Of 61 subjects, only one had a measurable open bite. Facts:

1. Now eighteen, the subject has a tongue thrust and a 2.5 mm. open bite measured at the midpoint of both maxillary central incisors.
2. This patient had no tongue thrust at either four years, nine months, or at eight years, two months.
3. The dental models taken at eight years show no open bite, but do show an overjet.
4. The subject received complete orthodontic treatment, consisting of braces for two years, and a retainer (still in place) for five and one-half years.
5. No tongue thrust therapy was recommended or received. (As far as I'm concerned, this case is not closed.)

Subjects With No Orthodontic Treatment. We were really more interested in these 41 subjects than in the 20 who did receive orthodontic treatment. We wanted to study interrelationships among dental occlusion and tongue thrust in untreated patients.

Tongue Thrust and Orthodontically Untreated Subjects. Of the 41 who received no orthodontic treatment, 17 (41.5%) were tongue thrusting at the age of eighteen years. (You will remember from earlier in the article that of the 20 who did receive orthodontic treatment, 9 (45%) were tongue thrusting at eighteen.) In this study, there was little difference in percentage of subjects who retained a tongue thrust pattern between the group who received orthodontic treatment and the group who did not receive it.

Tongue Thrust and Occlusion at Eighteen Years. We are considering subjects who were untreated orthodontically. Because of the attention called to the subjects teeth, it is probable that a greater percentage of those children who could benefit from orthodontic treatment than would be found in a non-researched population did indeed receive it. For that reason, our untreated subjects have, as a group, essentially normal occlusion. This fact depresses the significance of any findings concerning relationships between malocclusion and tongue thrust in the orthodontically untreated subjects. Nevertheless, the data are presented here for whatever interpretation may be given them.

Figure 4 summarizes data on three types of anterior occlusal measurements with reference to presence or absence of tongue thrust. None of the subjects who received no orthodontic treatment had open bites. The mean overjet of all subjects with tongue thrust was 2.00 mm. Mean overjet of all subjects with no tongue thrust was 1.96 mm. The mean percentage of overbite (the portion of the lower incisors covered by the upper incisors) in the tongue thrusters was 42.6%; in the non-tongue thrusters, 43.9%. Figures for thrusters and non-thrusters are very similar for all three anterior measures.

Overjets. We examined changes in overjet in tongue thrusters and non-thrusters between the ages of eight and eighteen years. The figures are all small, because there was little overjet to begin with.

1. Five subjects who did not receive orthodontic treatment had a tongue thrust at eight and at eighteen. The mean increase in overjet in these subjects was 0.20 mm.
2. Seven subjects, untreated orthodontically, had a tongue thrust at eight, but none at eighteen. The mean decrease in overjet in these subjects was 0.14mm.
3. Ten subjects, untreated orthodontically, had no tongue thrust at eight years, but did tongue thrust at eighteen. Their mean increase in overjet was 0.44mm.
4. Nineteen subjects in the non-orthodontic group had no tongue thrust at either age. Their mean decrease in overjet over the ten-year period was 0.05mm.

Thus, there was a small decrease in overjet among those who had no tongue thrust at eighteen years, and a small increase in overjet in subjects who had a tongue thrust at eighteen years. The collective means in these two groups were +.38 in the eighteen year old tongue thrusters, and -.09 mm. in the eighteen year old non-thrusters.

Open Bite. As stated earlier, none of the orthodontically untreated subjects had an open bite at eighteen years. Only four subjects of the 61 in the study had had open bites at four years, nine months, and at eight years, two months. By the age of eighteen, here is what had happened to these four:

Two had received complete orthodontic work. Both now had normal occlusion.

One no longer had an open bite, but had a 60% overbite and a 2mm. overjet.

Overbite. Subjects with no orthodontic treatment had no open bites, so by definition all had some degree of overbite. Most textbooks say that the upper incisors normally cover 1/3 to 1/4 of the surface area of the lower incisors. Probably all would agree that any overbite in excess of 50% would be considered a malocclusion. For that reason we dichotomized our subjects into two groups, those with more than, and those with less than, a fifty per cent overbite. Of the 26 non-tongue thrusters in the group of 41 subjects, 6 or 24%, had a significant overbite. Of the 15 tongue thrusters, 6 or 40%, had a significant overbite.

FIGURE 4
18-YEAR OLD SUBJECTS RECEIVING NO ORTHODONTICS:
MEAN MEASURES OF ANTERIOR OCCLUSION AND TONGUE THRUST

	OVERJET	OPEN BITE	OVERBITE
TONGUE THRUST PRESENT (15 SUBJECTS)	2.00 mm.	NO SUBJECTS WITH OPEN- BITE	42.6%
NO TONGUE THRUST (26 SUBJECTS)	1.96 mm.	NO SUBJECTS WITH OPEN- BITE	43.9%

Summary. Data reported on malocclusions and tongue thrust in this group of subjects have not been analyzed statistically. Some trends are seen in the figures, however:

1. Orthodontic treatment did not seem to consistently eliminate tongue thrust (9 of 20 treated patients were still tongue thrusting at eighteen years).
2. There was a trend for eighteen year olds with a tongue thrust to have experienced a slight increase in overjet over the years, and for eighteen year olds without a tongue thrust to have experienced a slight decrease in overjet.
3. There was a notably small percentage of subjects with open bite in this population of 61 eighteen year olds.

A. In the total group, four subjects had open bites at four years, nine months, and had retained them over the next four years. Two of these were successfully treated orthodontically, and the open bites of the other two corrected spontaneously.

B. One subject had no open bite at eight years nor at four years, nine months. This subject was treated orthodontically, but later relapsed to a 2.5 mm. open bite, in spite of 2½ years in braces and 5½ years with a retainer.

4. Proportionately more orthodontically-untreated tongue thrusters had a greater than 50% overbite than untreated non-tongue thrusters.

Tongue Thrust and Etiological Factors. Two associated factors were examined in this study, both pertaining to the upper respiratory tract: Nose/mouth breathing and surgery for removal of tonsils and adenoids.

Nose and mouth breathing. Figure 5 shows per cents of primarily

FIGURE 5

NOSE AND MOUTH BREATHING AND TONGUE THRUST AT 18 YEARS
OF 61 SUBJECTS:

	TONGUE THRUSTERS AT 18	NON-TONGUE THRUSTERS AT 18
NOSE BREATHERS	16 = 61.5%	26 = 74.3%
MOUTH BREATHERS	10 = 38.5%	9 = 25.7%
TOTAL	26	35

mouth breathers with tongue thrust at eighteen years of age. The information was obtained by direct question, so its reliability is questionable.

Of the 61 subjects, 26 were tongue thrusting at eighteen and 35 were not. Of the 26 tongue thrusters, 16, or 61.5%, were primarily nose breathers, and 10, or 38.5%, were primarily mouth breathers. Of the 35 non-thrusters, 26, or 74.3%, were primarily nose breathers, and 9, or 25.7%, were primarily mouth breathers. The respective ratios of nose breathers to mouth breathers in tongue thrusters and non-thrusters are 1.6 to 1.0, and 2.9 to 1.0.

Tonsil and adenoid removal. Fifteen of 61 subjects had had "T & A's" by the time they were eighteen. Five of the 15 had a tongue thrust and 10 did not. Twelve of the 15 were primarily nose breathers, and 3 were primarily mouth breathers. Because of the discrepancy in group sizes, no comparisons were made between those who had had the surgery and those who had not.

Lingual resting postures and tongue thrust at eighteen years. These data (Figure 6) were also of questionable validity. Subjects were asked to tell where their tongue was resting in an off-guard moment while they were waiting to be examined. We report the data aware of their relatively little worth.

More of the normal swallows (45.2% as compared with 33.3%) rested their tongue against the lower teeth. More of the tongue thrusters (43.3% as compared with 16.1%) rested the tongue against the upper teeth. More of the normal swallows (38.7% compared with 23.3%) rested the tongue against the upper gums. In the total group, the most common resting place for the tongue was against the lower teeth.

FIGURE 6

RESTING POSTURES AND TONGUE THRUST (AT 18 YEARS)

RESTING POSITION	TONGUE THRUSTERS	NORMAL SWALLOWERS	TOTALS
LOWER TEETH	10 (33.3%)	14 (45.2%)	24
UPPER TEETH	13 (43.4%)	5 (16.1%)	18
UPPER GUMS	7 (23.3%)	12 (38.7%)	19
TOTALS	30	31	61

Therapy for tongue thrust. Only 4 of the 61 subjects received therapy for tongue thrust. They are identified in Figure 7 by their initials. Two had orthodontic work. Two had tonsils and adenoids removed. Three had allergies affecting the upper respiratory system. At eighteen years, only one, who had not received orthodontic treatment, had a significant overjet. Another one had a significant overbite (this subject had received orthodontic treatment) and none had an open bite.

The study was only incidentally concerned with therapy for tongue thrust. The small number of subjects who received oral myofunctional therapy precludes the drawing of any conclusions regarding the effectiveness of the training.

Summary and Discussion. This is the final report on a 13½ year longitudinal study which began with 225 subjects and ended with 61. As usual, it leaves more questions unanswered than answered. We do not know yet whether therapy for tongue thrust facilitates orthodontic treatment or reduces orthodontic relapse. We do not know which children, whether they receive orthodontic care or not, will be tongue thrusting during or after adolescence. We do not know which children will spontaneously correct minor malocclusions without orthodontic treatment.

FIGURE 7

SUBJECTS WHO RECEIVED THERAPY FOR TONGUE THRUST

	ORTHODONTIC	T & A	ALLERGIES	OVERJET		OVERBITE		OPEN BITE	
				AT 8.2	AT 18.0	AT 8.2	AT 18.2	AT 8.2	AT 18.0
CC (M)	NO	YES	YES	2 mm	1-1/2 mm	58%	0	0	0
WD (M)	YES	YES	YES	4 mm	0.5 mm	36%	63%	0	0
RR (M)	NOT YET	NO	YES	5.5 mm	5.0 mm	-	19%	3-1/2 mm	0
HR (F)	YES	NO	NO	3.0 mm	2.0 mm	27%	32%	0	0

We are reasonably certain that orthodontic treatment does not eliminate tongue thrust with any appreciable degree of consistency. There is strong support in the literature for the effectiveness of tongue thrust therapy in correcting tongue thrust. (Case, 1965; Christofferson, 1970; Overstake, 1970; Toronto, 1970.) The present study presents convincing evidence that the incidence of tongue thrust does not decline through adolescence, but rather increases slightly. Incidence studies which in the past have reported a decline with increasing age have involved diagnostic procedures and/or criteria that subsequent research found to be inappropriate. This study also reports findings that demonstrate the unpredictability of tongue thrusting. Patients using the tongue in a normal manner before adolescence, or before orthodontic treatment, may develop a thrusting pattern at some time during treatment, or during adolescence. Until we know more about specific relationships among tongue thrust, orthodon-

tic work, and developing malocclusions, it would seem prudent for us to keep objective data on our patients and to be alert for the possibility of this and other detrimental oral habits.

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