The Open Bite: Physiology And Occlusion[1]

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Introduction

The clinical problems associated with deviate swallowing continue to warrant investigation of this habit. Other than the obvious protrusion of the tongue between the teeth during deglutition in tongue thrusters, differences found between this group and normal swallowers have been slight. Extensive clinical observation has shown that aberrant tongue habits do not always affect the dentition in the same way. Present knowledge permits us, however, to distinguish two types of occlusions associated with this habit: that of a partially occluded dentition or "open bite" in which "the vertical development is insufficient to permit teeth to meet their antagonists in the opposite arch resulting in a localized absence of occlusion",[1] and that of a complete contact occlusion in which there is no absence of intermaxillary occlusion regardless of their state of normal occlusion or malocclusion. This shows a diametrically opposed reaction to the tongue-thrust habit and leaves no alternative but to search for other factors associated with the habit that do not involve movements of the tongue. One of these factors relates to movement of the mandible during deglutition and moves into the realm of a dynamic evaluation. Part of the classic description of tongue thrusting assigns a passive role to mandibular movement in which the teeth are not occluded during swallowing. Of necessity, a tongue thruster with a complete contact occlusion would follow this description, but it would not necessarily be true of the partially occluded thrusters. This study was designed to determine the role of mandibular movements, i.e., jaw opening movements, in swallowing in both of the above described tongue-thrust groups and in a normal swallowing group.

Review of Literature

The swallowing process has been adequately described for many years, but it has not been until recent years that a variation in the swallow pattern has been observed and defined. This variation has been termed tongue thrusting, aberrant swallowing, atypical swallowing, visceral swallowing and many others, all describing basically the clinically observed tongue protruding between the teeth during the swallow.

Studies oriented toward comparison of the normal and abnormal swallow have shown some differences. Kydd, Akamine, Mendel and Kraus[2] found that abnormal swallowers exerted more pressure upon the maxillary anterior teeth for a longer period of time than did normal swallowers. Law,[3] in a cinefluorographic study, found that only in the initiation phase of the swallow was a consistent difference found in the tongue activity of the two groups. Kydd and Neff[4] found that the frequency of deglutition in the normal swallowing group was approximately twice that of a tongue-thrust sample population. Shelton, Bosma and Sheets,[5] in a study of monozygotic twins (in which one twin was an abnormal swallower and

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the other was not), concluded, after a comprehensive study, that moderate motor disability in the abnormal subject was responsible for the differences that were found. Other differences that could relate to deglutition, such as the absence of gag-reflex in abnormal swallowers, is suggested by Whitman.[6]

Subtelny and Sakuda,[7] in a cephalometric study comparing the two groups, found some skeletal differences that were significant. Backland[8] found no significant correlation in a sample with and without tongue thrust between the type of swallow and the following factors: A-B difference, jaw height, overjet, incisor inclination and width of maxillary dental arch. Tulley[9] reports that, with electromyographic skeletal studies, "It is possible to determine whether or not the teeth are placed together in swallowing." He reported that, with a "teeth together" swallow, the masseteric contraction is marked while the circumoral contraction is minimal. In a "teeth apart" swallow the activity is reversed.

Method

This study was approached from a combination of radiographs and physical measurements. The radiographic record was obtained by taking a series of oriented head films at the rate of five per second for three seconds during the swallowing process.[10] To enhance the contrast of the radiographic picture, the midline of the palate and the midline and tip of the tongue were coated with the radiopaque material Microtrast. A small portion of this material was also utilized as a bolus which was swallowed.

A record of four physical measurements was obtained from four different devices, each designed to yield specific information on a specific function and read out on a four-channel pen recorder. The first of these devices consisted of a strip of .003″ by .150″ stainless steel band material molded across the occlusal of a posterior tooth and held in position by ligating it to the tooth with .009″ ligature wire. The ends of the ligature wire were then insulated and served as a lead. This same thing was done to an opposing tooth, and the leads were connected to a 6 volt electrical circuit that could be adjusted for adequate signal strength. Contact made between the dental arches would permit current flow and be recorded as a pulse on the recorder (Fig. 1).

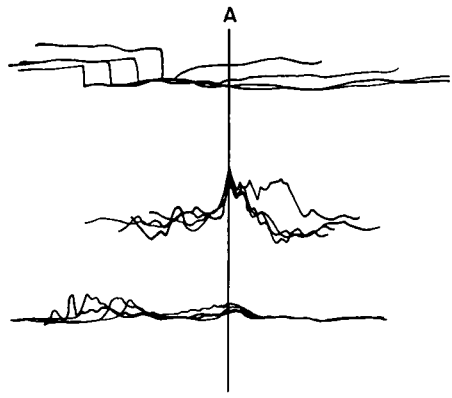

Fig. 1 A series of swallows and related readings oriented at point "A". This was recorded at 10 mm/sec. Top, occlusal contact pattern; middle, neck gauge pattern; bottom, transducer pattern.

The second device was utilized and previously described by Kydd and Neff[4] to record the act of swallowing. A mercury strain gauge, placed around the neck at the level of the thyroid cartilage, will produce a deflection of the recorder as resistance in the mercury column altered. Change in resistance is proportional to a change in length of the mercury gauge; therefore, a change in circumference of the neck can be accurately monitored. The act of swallowing produces a uniform signal which is duplicated upon each swallow (Fig. 1).

A third device was used to record the duration of forces exerted by the tongue on the lower anterior dentition. This was accomplished by using a

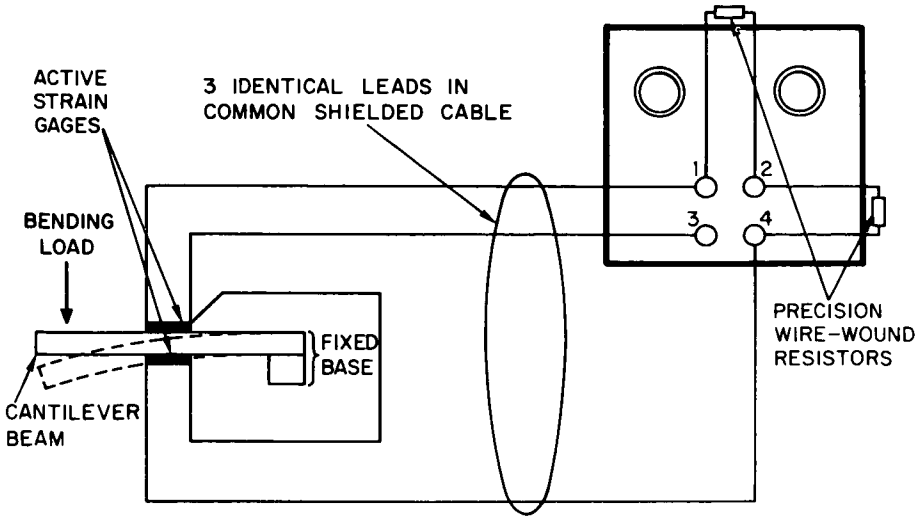

Fig. 2 Three-wire lead for temperature compensating wire strain gauges. The two gauges double the sensitivity per unit load.

strain-gauge transducer mounted on a cantilever beam (Fig 2). The gauge was mounted on the teeth by first placing dental compound on the fixed base of the gauge and then adapting this compound to the contour of the lingual of the lower anterior teeth. The compound was then hardened, the teeth dried, and the gauge bonded with Eastman 910, an instantaneously drying cement.

A fourth device provided a means of integrating the radiographic record with the other records. As each x-ray was exposed, a signal was produced causing a pulsed D.C. current which in turn produced a deflection on the pen recorder (Fig. 3).

Sample

The sample for the study was obtained by solicitation from a university population. Each individual who applied as a subject was accepted, and no attempt was made to evaluate the presence or absence of a tongue-thrust condition or to classify their occlusions. The sample consisted of thirty subjects, twelve males and eighteen females between the ages of twenty and forty.

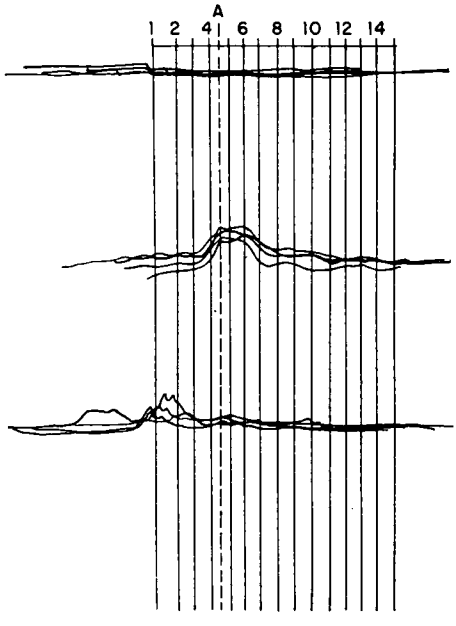

Fig. 3 A series of swallows and related readings superimposed at point "A" along with vertical solid lines indicating at which point the 15 x-rays were exposed. This was recorded at 25 mm/sec.

Procedures

As the subjects presented themselves, they were instrumented with devices placed within their mouths and around their necks. Once these various gauges were attached, the subjects were left alone for a half hour during which time they were permitted to relax and read without interference. During this period of time they not only accustomed themselves to the apparatus, but were also recording their involuntary swallows. After this introductory period the subjects were oriented in the cephalostat. The radio-opaqueing material was placed on the tongue, and the subjects were asked to swallow the bolus at which time a series of films were taken. A clinical evaluation was then made which consisted of an appraisal of the occlusion and the presence or absence of the tongue-thrust habit.

The data were evaluated in three steps. The radiographs were first traced on acetate paper wherein the soft tissues of the mouth and pharynx were outlined as were at least three of the most distinct landmarks of the cranial base and the spinal column (Fig. 4). This provided a method of superimposing the tracings on three stable landmarks so all movements seen in the series of tracings were absolute mandibular movements and not related to an overall movement of the head and neck. The radio-opaque material used to outline the oral soft tissues delineated these structures. By x-ray filtration techniques good definition of the laryngeal area was obtained. These sequentially numbered tracings were superimposed and graphs (line drawings) were made relative to the movement of all structures associated with the swallow.

The data obtained on the pen recorder were plotted by tracing. At each point where a swallow was indicated by neck gauge wave patterns, all the information recorded relative to that

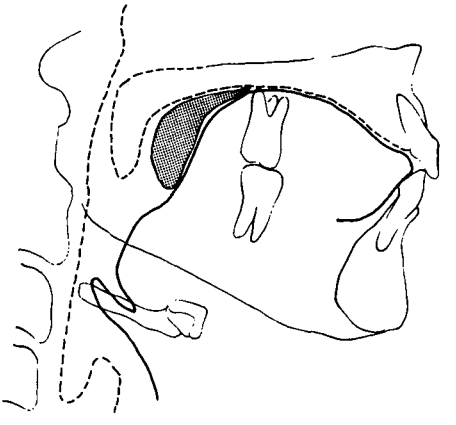

Fig. 4 Normal swallower. (Note the position of the tongue and the contact made between dental arches.)

swallow was traced. This included the contact made between the dental arches and the tongue force on the lingual of the mandibular incisor teeth. This oriented tracing could then be superimposed upon the next swallow tracing using as reference the constant neck gauge pattern. A point of reference along the neck gauge wave pattern has been termed "A" point and reflects the peak of the first upward deflection of the pen upon swallowing (Fig. 1). Each individual's record was evaluated according to the character of the tooth contact and tongue activity patterns with time relations measured to this "A" point. A series of from five to ten swallows were selected for each individual on the basis of clarity and freedom from extraneous movement.

These records of swallowing, tooth contact and tongue force were oriented to each other again through tracings. The record obtained during the swallow, through which the series of x-rays were taken, was traced as outlined above with the additional marks which indicated the precise moment at which a film was exposed. This made it possible to know what was occurring during a swallow with relation to the neck gauge pattern and point "A" (Fig. 3).

Time relationships between the two sets of records were, therefore, accurate to the one-fifth second, the interval time at which the film was exposed.

The subjects were classified as tongue thrusters or nontongue thrusters according to the radiographic picture they presented.

Results

Of the sample of thirty subjects, fourteen individuals were found to be tongue thrusters. Eight of these tongue thrusters were partially occluded (open bite) and routinely made intermaxillary contact upon swallowing (Fig. 5). The remaining six tongue thrusters without anterior open-bite occlusions did not make intermaxillary contact upon swallowing (Fig. 6). The normal swallowers, sixteen in number, had complete contact occlusions and all made intermaxillary contact during the swallowing process (Fig. 4).

Although the beginning of the tongue activity is variable, the reflex of swallowing produced a consistent intrasubject pattern of tongue activity as measured by the strain-gauge transducer mounted on the lingual of the lower anterior teeth and showed the following differences between the three abovementioned groups: In all of the open-bite tongue thrusters the tongue was withdrawn from the thrust prior to the completion of the swallow. In the completely occluded tongue thrusters all but one of the six demonstrated that the tongue remained in the thrust of a protrusive position after the swallow was finished. In the normal swallowers the termination of tongue activity and the swallow occurred simultaneously in twelve of the sixteen subjects (Fig. 7).

By this same measure the greatest tongue activity, as well as the greatest relative tongue pressures, was exerted prior to the reflex part of the swallow in all three groups and represented radiographically the preparatory phase

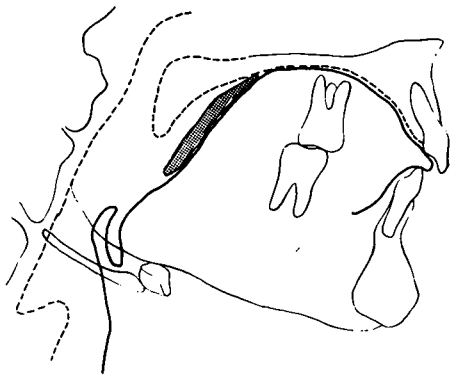

Fig. 5 A partial contact occlusion or open-bite tongue thruster. (Note the manner in which the dental arches are brought into contact upon swallowing.)

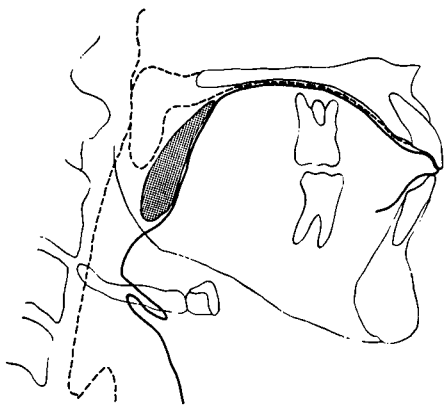

Fig. 6 A complete contact occlusion tongue thruster in the process of swallowing. (Note absence of contact between the dental arches.)

of the swallow under voluntary control. No difference as to this voluntary, tongue-activity pattern of duration of force was seen in any of the three groups. The only difference demonstrated radiographically was in the manipulation of the anterior portion of the tongue which protruded beyond the teeth in the tongue thrust groups.

Discussion

It has been the understanding of those concerned with the tongue-thrust habit that the tooth-apart swallow describes all those with the habit. With

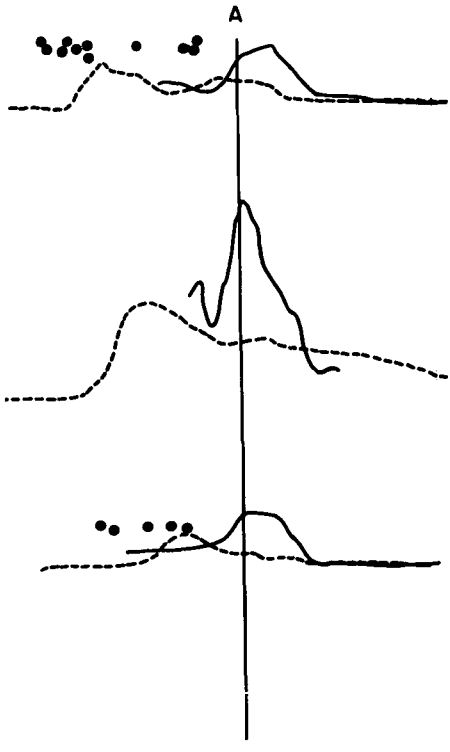

Fig. 7 The relationship between the duration of force application by the tongue to the lower anterior teeth (dashed line) and the duration of the swallow as measured by the neck gauge (solid line) in the three groups studied. Top, a partially occluded or open bite-thruster; middle, a completely occluded tongue thruster; bottom, normal swallower. Dots indicate point of occlusion between the dental arches. Vertical line indicates point "A".

this idea prevalent, focus would naturally be turned upon the tongue and the forces it exerts to explain its effect upon the dentition. It would be expected that an individual with an open-bite malocclusion would exert much greater tongue force on his anterior teeth than an individual with a normal dentition.

Even though Kydd, et al.,[2] found a significant difference between the forces placed upon the teeth by the tongue and lips in the normal and abnormal swallowers, they estimated the frequency of swallow to be the same in both types of swallowers. Kydd and Neff[4] have shown that the frequency of swallowing is significantly less in abnormal swallowers which would have the tendency to equalize the total force applied to the teeth during a day by the tongue in both types of swallowers. It is obvious, however, that there is an abnormal force exerted on teeth in an open-bite malocclusion and, if the force cannot be attributed actively to the tongue, it must then assume a more passive role and active forces must be assigned elsewhere. This study has shown that the tooth-apart swallow cannot be used to describe all tongue thrusters as the open-bite tongue thrusters habitually occlude their jaws upon swallowing. That the jaws are brought into contact upon swallowing assumes a more active contraction of the muscles of mastication, a view substantiated by Tulley[9] and Graf,[11] thereby, supplying an active force applied around a passively positioned tongue between the dental arches in the area of the open bite. In those individuals to whom the tooth-apart swallow can be applied, there remains a complete occlusion without anterior open bite, but with no intermaxillary contact upon swallowing, thereby, indicating passive mandibular movement which will not distort the dentition even though the tongue is interposed between the dental arches.

Although this study did not quantify the force application of the tongue to the lingual of the lower anterior teeth, the duration of force was measured. In relation to the swallow itself the partially occluded tongue-thruster withdrew his tongue from between his teeth earlier in the swallow than did the complete contact occlusion tongue-thruster whose tongue persisted between the teeth in some cases for prolonged periods. This shows that the actual presence of the tongue between the dental arches is not always a determining factor in

distorting the dentition but, again, indicates a more passive role of the tongue in the whole problem of tongue thrusting.

This study also raises some questions pertaining to the "tongue thrust therapy" programs. In most methods of tongue training great stress is placed upon bringing the dental arches into contact upon swallowing, when in reality they usually are.

The radiographic picture showed none of the other characteristics ascribed to tongue thrusters such as minimal laryngeal excursion and insufficient elevation of the posterior portion of the tongue, both of which are anticipated and approached in tongue therapy programs.

Conclusion

This study has shown that there are two types of tongue thrusters according to the type of static occlusions they present: that of a partially occluded or open-bite tongue-thruster and that of a completely occluded tongue-thruster. The difference is thought to be the result of the manner in which the jaw is closed upon swallowing. In the partially occluded thrusters the dental arches made contact with each other during swallowing. In the subjects with completely occluded dentition no intermaxillary contact was made during swallowing. It is felt from these results that the presence of the tongue between the teeth alone is not enough to induce an open bite, but there has to be an active force applied around a relatively passive tongue to produce an open-bite distortion. This active force is thought to develop from the muscles of mastication used during swallowing.

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