Tongue-Tie

CHARLES E. HORTON, M.D.
HUGH H. CRAWFORD, M.D.
JEROME E. ADAMSON, M.D.
T. SHELLY ASHBELL, M.D.
Norfolk, Virginia

Perhaps not many subjects in medicine and dentistry have aroused as much controversy, have been surrounded by so much superstition, or have created as much concern among the lay public as tongue-tie. Even today, the controversy has not subsided, and although the subject is approached much more rationally than previously, one still finds physicians and dentists who clip every prominent lingual frenulum, while many of their colleagues strongly advocate no surgery at all, even in the more severe cases of tongue-tie. This paper is being presented with the hope that with a clearer understanding of the condition, unnecessary surgery can be avoided, and in those cases where a clear indication exists, a correct and beneficial operation can be performed.

Tongue-tie, or partial ankyloglossia, is manifested by an abnormally short and thick lingual frenulum (Figure 1). Degrees of tongue-tie vary from the very mild, having only a mucous membrane band (Figures 2 and 10a) to those in which both the frenulum and the underlying fibers of the genioglossus muscle are markedly fibrosed (Figure 3), to the rare, complete ankyloglossia where the tongue is actually fused to the floor of the mouth (Figure 4).

Although the terms *frenulum*, Latin for small bridle, and *frenum*, Latin for bridle, have been used synonymously for years, the Nomina Anatomica derived at the Sixth and Seventh International Congresses of Anatomists, Paris, 1955, and New York, 1960, chose to use the term *frenulum*. Accordingly, the vertical mucous membrane fold under the midline of the tongue is properly called **frenulum linguae.**

Historical Review

Spencer and Cade (*17*) described the condition and reviewed the early history of the treatment. Infants vary greatly in the degree of development of the tongue at birth. The tip of the tongue is relatively short

Drs. Horton, Crawford, and Adamson are on the staff and Dr. Ashbell was Senior Resident in plastic surgery, the Plastic Surgery Division, Norfolk General Hospital. Dr. Ashbell is now on the full time staff of the Mount Sinai School of Medicine, New York, New York.

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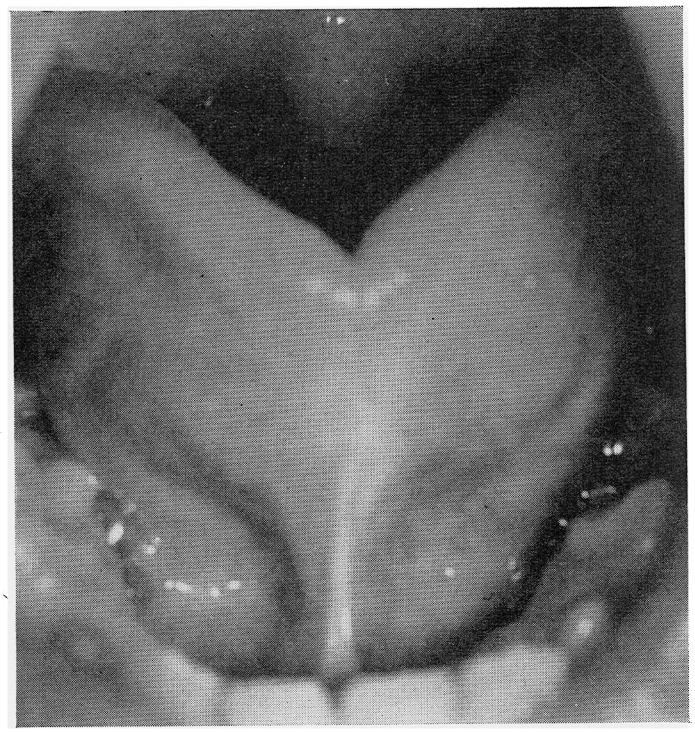

FIGURE 1. A typical tongue-tie which limits free motion of the tongue tip and which requires surgical correction. Note the short and thick lingual frenulum.

with the frenulum extending almost to the tip, yet the child can move the tongue between the gums and very soon protrudes it between the lips. In mentally retarded children, the functional development of the free portion of the tongue is sometimes retarded, as it may also be in the child who is delayed in teething and who has a delayed onset of speech. Hence arose the superstition that all "tongue-tie" must be corrected; this was handed down from ancient times by midwives, who not only tore the frenulum with dirty finger nails, but, in addition, stripped up the tongue. The wound thus created often resulted in an infection which spread to other intraoral structures. The stripped-up tongue occasionally fell backwards and caused asphyxia by "tongue swallowing". Hemorrhage from the lingual artery too often proved fatal. An inevitable scar followed and, as a result, the tongue secondarily became fixed in a pathological condition of ankyloglossia. In the 20th century, the practice of simple clipping and stripping of the tongue has been almost abandoned. Like other superstitions, however, that concerning "tongue-tie" dies hard, and even today there are frequent occasions when parents desire clipping of a normal lingual frenulum.

As part of their historical review, Spencer and Cade (*17*) describe

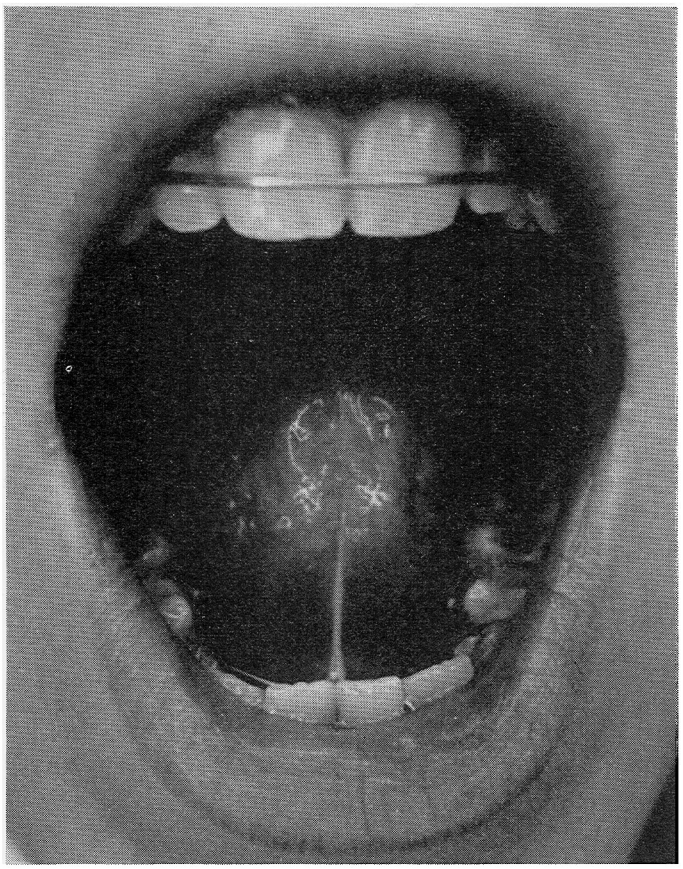

FIGURE 2. A mild degree of tongue-tie consisting only of a mucous membrane band.

some noteworthy early writings on tongue-tie. Celsus (*3*) said, "The tongue in some is tied down from birth to the part underlying it, so that on this account they cannot even speak.... And indeed many, when they have healed, have spoken, but I have known that after the tongue has been undercut, so that it could be protruded well beyond the teeth, there has not followed a faculty of speaking". There is a similar passage in Paulus Aegineta (*1*). Ambroise Paré (*15*) advised, after the division of the frenulum, that the finger should be inserted to lift up the tongue, advice which caused the death of many infants. Fabrizio d'Aquapendente (*2*) said that midwives of his day kept a finger nail sharp, stripping up the tongues of *all* newborn infants. In 1742, Petit (*16*) introduced a slit in the flat end of a grooved director by which he could protect the deep lingual artery. In using the instrument, only the mucous membrane was to be divided, not the insertions of the geniohyoglossi, nor was the tongue supposed to be stripped up. Dieffenbach (*6*) in 1841 divided the frenulum of a stutterer, and published

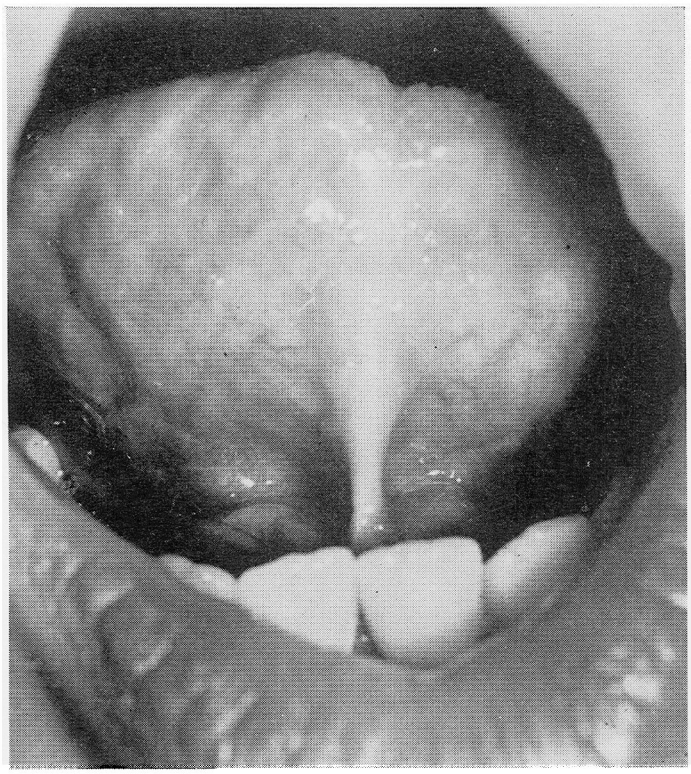

FIGURE 3. A marked degree of tongue-tie in which the motion of the tongue tip is limited by marked fibrosis of the lingual frenulum and the underlying fibers of the genioglossus muscle.

the case as a success. Relapse, however, soon followed, and other surgeons who copied him were equally unsuccessful. In 1897, Makuen (*12*) published three cases including one of a youth of 19 who had never been able to utter four consecutive syllables intelligibly; after division of the frenulum and the attachment of the genioglossi, he "could recite a scene from Shakespeare better than the average person". Spencer and Cade (*17*) reviewed these and other "successes" and considered them a result of "suggestion" overcoming a "neurotic element". They considered the treatment as rather violent and possibly dangerous.

In the early part of the present century, strenuous opposition was raised to the practice of frenulotomy and frenulectomy so that as a consequence, no surgery on tongue-tie is performed in many medical centers.

Normal Development of Tongue Function

The tongue is an accessory organ of importance in deglutition, mastication, and speech. It also exerts influence on dental occlusion, growth, and facial form. At birth, the tongue is usually short with the frenulum

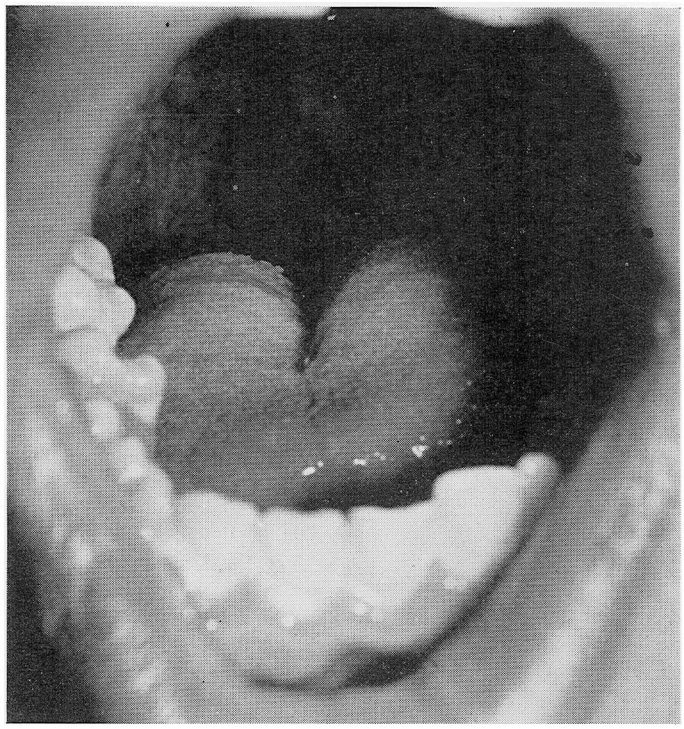

FIGURE 4. The complete ankyloglossia where the tongue is actually fused to the floor of the mouth.

extending to the tip. At times, a bifid-like tip may be noted. During the early weeks of life, the tongue grows longer and thinner, the frenulum stretches and its tongue attachment often recedes to a lower position.

In the infant, the normally mobile tongue is unconfined by teeth and thus extends outward between the maxillary and mandibular arches. On swallowing, the infant keeps his jaws parted and the tongue is placed between the occlusal gum pads to produce a vacuum for sucking. With the eruption of teeth, the tongue remains confined within the oral cavity. At approximately 2½ years of age, when all deciduous teeth have erupted and are in occlusion, the "infantile swallow" is replaced by the "adult swallow". In the adult swallow, the lips are closed, the teeth held in occlusion, and the tip of the tongue raised and pressed against the anterior portion of the palate, sealing the anterior portion of the mouth. At the same time, the hyoid bone and larynx are elevated, while the nasal cavity and respiratory openings are also sealed (*19*).

Abnormal Tongue Function

For unknown reasons, some children do not outgrow their infantile swallow and continue to swallow with their jaws apart. The teeth are

not placed in occlusion and the tongue is thrust between the separated dental arches and is confined only by the contracting lips and cheeks. The continuous interposition of the tongue between the arches results in open bite malocclusion, where, when the dental arches are closed, the occlusive surfaces of the anterior teeth do not achieve contact when the mandible is brought into centric occlusion. During swallowing, the tongue is repeatedly thrust between the teeth and interferes with the natural tendency of the upper teeth to seek occlusion with the opposing lower teeth. Thus the upper anterior teeth are prevented from growing down, and the lower anterior teeth from growing up to the plane of occlusion. This open-bite is initiated and perpetuated by the persistence of swallowing with the teeth apart.

The growing tongue of the normal infant can be raised to the roof of the palate with the mouth open. Any band or condition restricting freedom of motion of the tip of the tongue and preventing it from touching the anterior palate may interfere with the development of an adult swallow and perpetuate the infantile swallow, resulting in an open bite deformity (*19, 21*) (Figures 5b and 5c). Here the plastic release of the ankylosis of the tongue is an important adjunct to orthodontia (*18*).

Bone growth and molding are markedly influenced by function and by the stress and strain applied. Bone remains malleable throughout the life of an individual, but during the growth phase of infancy and childhood, it is much more sensitive and can be molded easily by any form of sustained or repeated stress or pressure. The forces responsible for the molding of bones include function, gravity, and those applied by soft tissues. The latter category is not well recognized but becomes obvious when one remembers the prominences or tubercles which develop at the site of attachment of tendon, the groove in bone which results from a closely applied artery, or the molding of the protuberant premaxilla by a repaired cleft lip. The jaws, which grow *in utero* along a mostly hereditary pattern, develop after birth under the influence of their function. As growth proceeds, well-proportioned tongue thrust, repetitive during deglutition against both maxillary and mandibular arches, helps control their harmonious forward and lateral growth so that normal facial proportions are maintained. The influence of tongue thrust on mandibular growth and development is especially noteworthy. Eskew and Shepard (*9*) reported an extremely rare case of congenital aglossia. In this man of 22 years, a complete absence of the tongue was associated with a mandibular arch of miniature proportions. This extreme failure of mandibular arch development appeared to provide the repetitive thrust on which this development depends. Conversely, any limitation of the free upward motion of the tongue, which directs tongue thrust forward only, will result in excessive growth of the anterior portion of the mandible. A classic example of this is noted in infants with Pierre-Robin syndrome treated by the Beverly

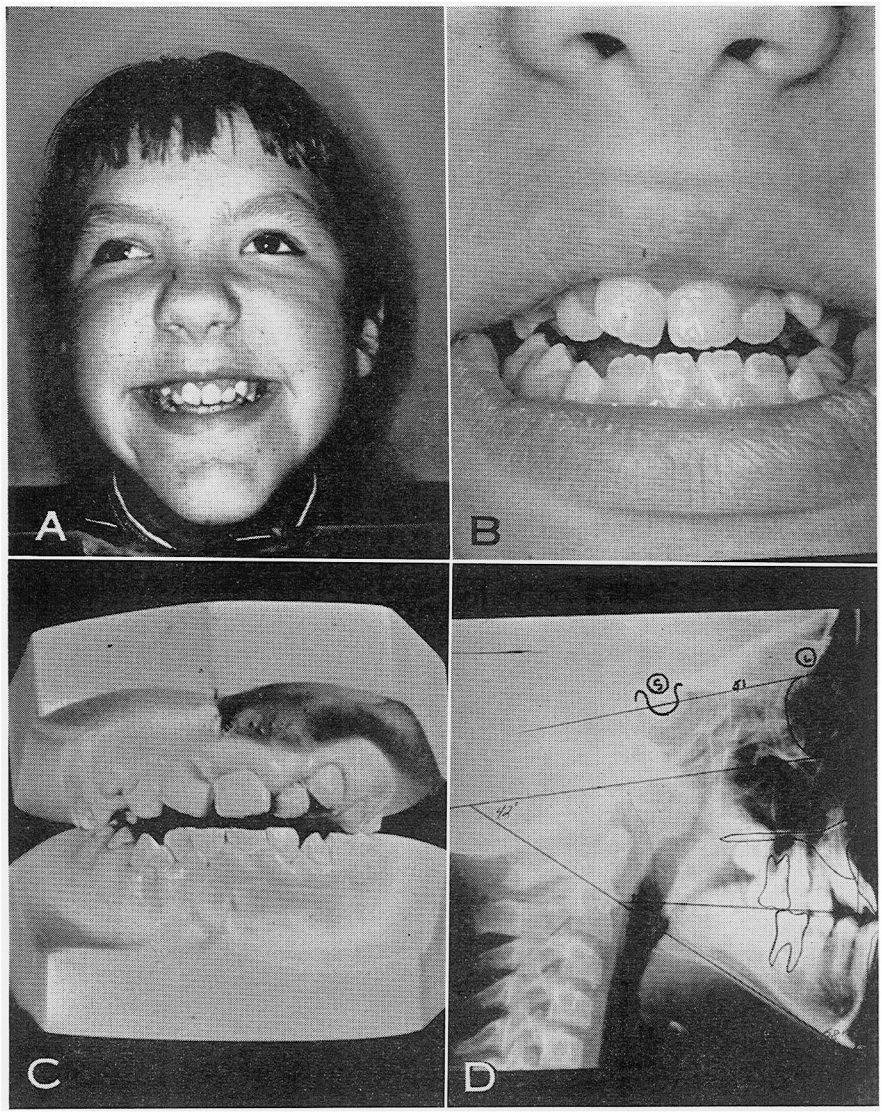

FIGURE 5. *Upper left,* girl aged 9, with a moderate tongue-tie, an open bite deformity, and an early mandibular prognathism; *upper right,* photograph; *lower left,* dental model of the open bite malocclusion; *lower right,* her cephalometric X ray reveals an increased Frankfort-mandibular plane angle of 42° (normal = 25° ± 5°) and a marked vertical enlargement in the mentum when compared with the height at the angle.

Douglas operation (*7, 20*) where surgical tongue-to-lower-lip-tie is produced to prevent these micrognathic infants from asphyxia by "tongue swallowing". This surgical tongue-tie apparently produces a marked increase in the growth of the anterior portion of the mandible.

Similarly, ankyloglossia, by restricting the free movement of the tongue, produces an exaggerated anterior thrusting of the tongue against the anterior body of the mandible which may produce mandibular prognathism (*19*, *21*) (Figure 5a). On cephalometric X rays (Figure 5d), an increase in the Frankfort-mandibular plane angle is noted in these cases. This measurement represents the angle between the Frankfort line and the tangent along the inferior border of the mandible. In children with centric occlusion and harmonious facial growth features, it is "normally" 25 degrees, plus or minus 5 degrees.

The presence of early prognathism and the desire to prevent its development constitute a valid indication for the surgical correction of any significantly prominent degree of tongue-tie (*18*) (Figures 5a and 5d).

In the elderly, a prominent lingual frenulum which does not limit tongue motion, may, however, repeatedly dislodge the lower plate of a denture-wearer when the tongue is elevated. This is another indication for surgical obliteration of the lingual frenulum (*8*).

Tongue-Tie and Speech

As mentioned previously, tongue-tie was believed to be a cause of major speech disorders as early as the time of Christ, when it was first described by Celsus (approximately 31 B.C. to 14 A.D.). Stuttering, lisping, and retardation in speech were attributed to tongue-tie by both professional and lay persons, as they are sometimes even today. Frenulotomy, therefore, was practiced widely until the early part of the present century. The converse attitude developed when the serious complications often encountered and the minimal degree of success obtained in the correction of speech disorders by frenulotomy or frenulectomy led most disciplines to a stand in which they considered surgical intervention in tongue-tie as never indicated.

Dr. James C. Shanks, Jr.,[1] a speech pathologist, indicates that, in his opinion, one's attitude to the relationship between tongue-tie and speech disorders depends on his approach to the problem. He feels that if one asks the question "Does tongue-tie cause speech defects?", the answer must be in the negative. In analyzing the sounds that theoretically might be impaired, he noted that the *th* sounds (voiceless, as in the word *thin*; voiced, as in the word *then*), which are the consonants most likely to be affected, require only that the tongue tip be protruded several millimeters beyond the incisor edges. Seldom does the lingual restriction preclude this tongue position. Compensation for restriction may involve, at worst, a cupid's bow of the tongue tip with the midline retruded relative to adjacent anterior lateral margins of the tip. Similarly, the tongue tip sounds of *n*, *t*, *d*, and *l*, which usually involve tongue tip elevation to the alveolus or rugae, may be compensated by

[1] Personal communication. James C. Shanks, Jr., Ph.D., Professor of Speech Pathology, Indiana University Medical Center, Indianapolis, Indiana.

dentalization; that is, the tip goes forward and up. An acoustically acceptable sound can result. The *r* sound is distinctive in that it requires two "humps" of the tongue, of which the anterior one merely requires the tip to be free of contact. Here, mandibular elevation can assist in compensating for lingual restriction. The *s* and *z* sounds may be made in two ways: a) with the tongue tip behind and below the lower incisor edge, or b) with the tip against the palatine rugae, leaving a median groove open for turbulent air escape. If the upper central incisors are missing, the speaker may use the second alternative; with the tip of the tongue held down, as in tongue-tie, the tongue dorsum can achieve compensatory occlusion against the palatal rugae.

If, instead of direct cause-effect reasoning, one asks, "Does tongue-tie *contribute* to difficulty in rate and range of articulation?", an affirmative answer must be given. That is, compensation is needed; in turn, such compensation may be affected by factors such as dentures, missing incisors, tongue size, sensory and motor function of the tongue, as well as the degree of ankyloglossia.

From a speech pathology viewpoint, then, factors to be considered for surgical correction of tongue-tie are: a) anteroposterior length of the frenulum; that is, how far does it extend toward the tongue tip, and b) vertical shortness of frenulum; that is, how high does it allow the tongue tip to be raised (*17*) (Figure 10a).

Anatomy

Figures 6 and 7 give a schematic indication of the anatomy of the muscles and undersurface of the tongue.

Histology

On microscopic examination of tongue-tie, the mucosa of the frenulum is fibrosed. Fibrous tissue also replaces underlying fibers of genioglossus muscle to a varying degree (Figure 8).

Incidence

Reliable data about incidence of tongue-tie have not been reported. In a survey of birth certificates, DePorte and Parkhurst (*5*) found what they considered a pathological tongue-tie in 99 out of 273,604 live births. McEntry and Gains (*13*) found only 4 "seriously shortened frenums" in 1,000 children with speech disorders. Oldfield (*14*) feels that a congenitally short frenulum linguae "is relatively common", while Green (*10*) deplores the lack of good statistics. Nowhere in the literature were we able to find an analysis by sex or race.

Diagnosis

Since ankyloglossia is not always apparent by observing the undersurface of the tongue but is rather dependent on the range of motion

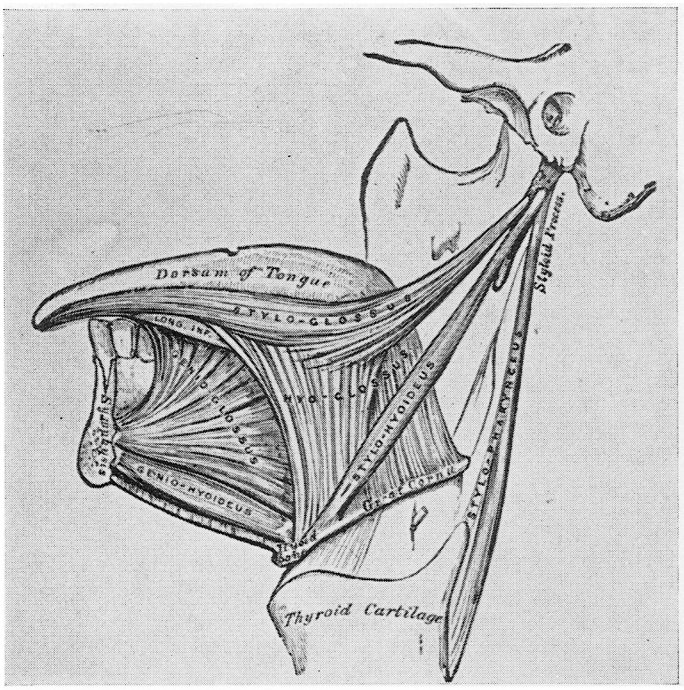

FIGURE 6. Extrinsic muscles of the tongue. The flat, triangular genioglossus muscle is noted. (Courtesy of H. Gray, *Anatomy of the Human Body*, 27th ed. Lea and Febiger: Philadelphia, 1959.) (*11*)

allowed by the genioglossus muscles, the diagnosis may be difficult, especially in infants. Commonly, in children of school age or in their early teens, tongue-tie is found when an orthodontist is consulted for open bite malocclusion, or when difficulties in speech are noted.

When the child is old enough to cooperate, moving the tongue through its maximum range will reveal tip restriction (Figures 1, 10a). In infants, elevating the tip of the tongue passively with a tongue blade may demonstrate the short frenulum which restricts the tip of the tongue. Palpation of the tight genioglossus muscle on the undersurface of the tongue will help confirm the diagnosis.

Review of Cases

102 cases of tongue-tie were referred to us over the 9-year period of 1958 to 1967. Of these, only 57 had a tongue-tie of sufficient degree to require operation. Sex distribution was equal (29 male and 28 female). Only one was Negro. Ages ranged from 8 months to 59 years with the majority (31) in the 10–20 year level. Five were under 3 years, 19 were between 5 and 10 years, one was in her thirties, and one was 59 years old. Interestingly, 37 were referred by orthodontists, 10 by speech pathologists, 8 by pediatricians or general practitioners, and 2 by general

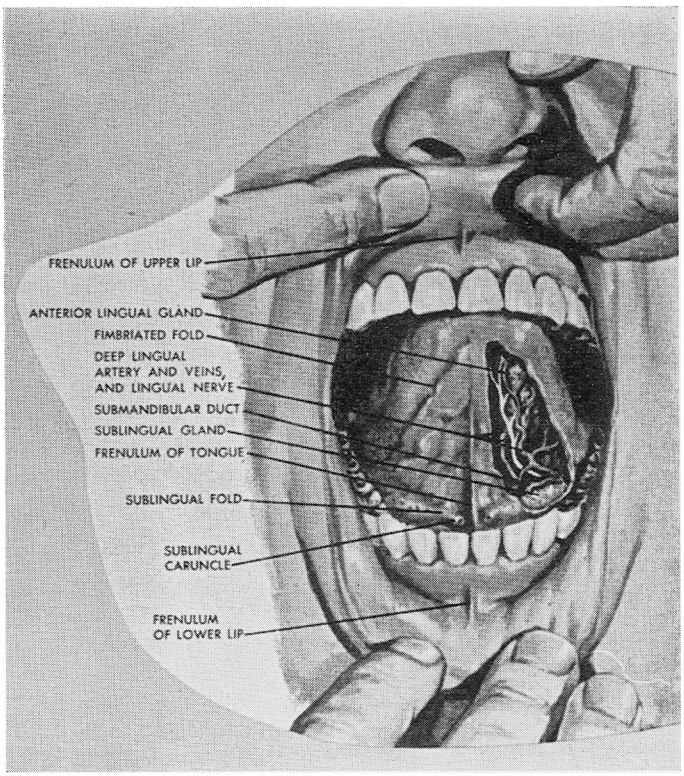

FIGURE 7. The inferior surface of the tongue showing the superficiality of nerves and vessels and their close proximity to the lingual frenulum. (Copyright: *The CIBA Collection of Medical Illustrations* by Frank H. Netter, M.D.)

dentists. In only one case was the release inadequate and a secondary operation necessary.

Surgery

If one accepts the position that pathological dental and speech problems can result from an abnormally adherent tongue, a consideration of cure and prevention must be entertained. The only way to effect the correction of a true tongue-tie is by surgery. For surgery, we prefer that the child be older than 5 years, but in cases of severe tongue-tie, we will operate on younger children if their general health is good.

To achieve release of ankyloglossia, several surgical procedures have been used. They include the previously mentioned ripping of the frenulum with a finger nail or sharp instrument; electrocoagulating the frenulum; excision of the frenulum with wound edges closed in a horizontal direction; excision of the frenulum, and if necessary, the involved genioglossus muscle fibers, and closing with Z-plasties. No surgical procedure should be done that does not use adequate anesthesia

FIGURE 8. Section of the lingual frenulum in moderate tongue-tie. Fibrosis and fibrous tissue replacement of underlying muscle are especially noteworthy.

and allow good exposure and visualization. If the tongue is bound by a thin mucosal frenulum, occasionally simple section of the band may provide adequate release. On the other hand, this is the type of frenulum that will usually stretch without operative intervention. Frenulotomy, that is, the division or electrocoagulation of the thick tough fibrous frenulum of the typical ankyloglossia, is not only inadequate but the scarring and adhesions which inevitably follow often result in a recurrence which is more severe than the original tongue-tie. Excising the frenulum and closing the edges of the mucous membrane in a horizontal direction may produce a more severe ankyloglossia. Only a frenulectomy, a genioglossus myotomy, and mucous membrane closure with Z-plasties will ensure a successful and permanent cure.

The Z-plasty is a method by which plastic surgeons break up and lengthen a linear scar or fibrous band. It provides an increase in length which can be calculated and planned mathematically. Furthermore,

the Z-plasty breaks up the surgical band into a longer line which runs in zig-zag fashion so that the tissue tensions are distributed in different directions. This relieves the pull on the wound, mitigates against wound disruption and allows for better healing.

The principle of the Z-plasty was first described by Denonvilliers in 1856 for the release of an eyelid scar (*4*). Since that time, it has been refined and perfected and is now utilized in almost every part of the body. It is a common operation in plastic surgery.

Although it appears complicated, the standard Z-plasty consists of the cutting of wound edge flaps in the form of the letter "Z" or its

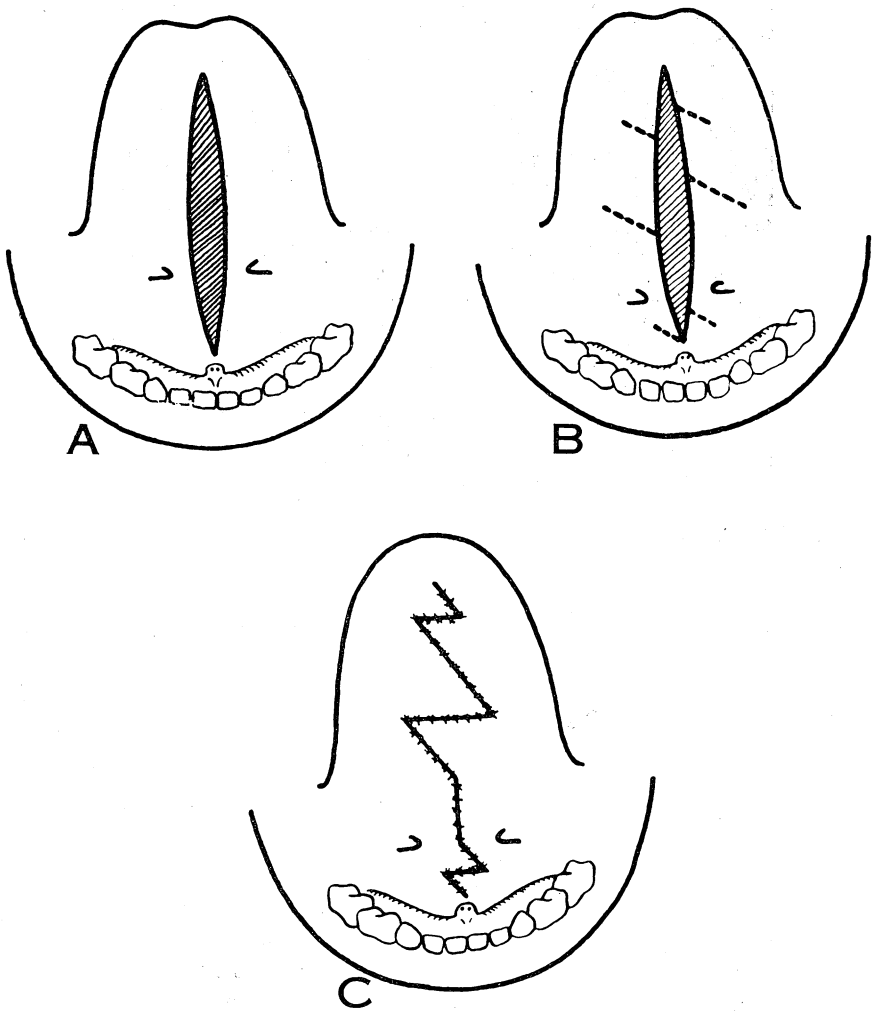

FIGURE 9. Schematic illustration of the Z-plasties in the plastic correction of tongue-tie. *Upper left*, excision of the lingual frenulum and incision of the fibrosed portion of the underlying genioglossus muscle; *upper right*, three Z-plasties are cut; and *lower*, Z-flaps were transposed and sutured.

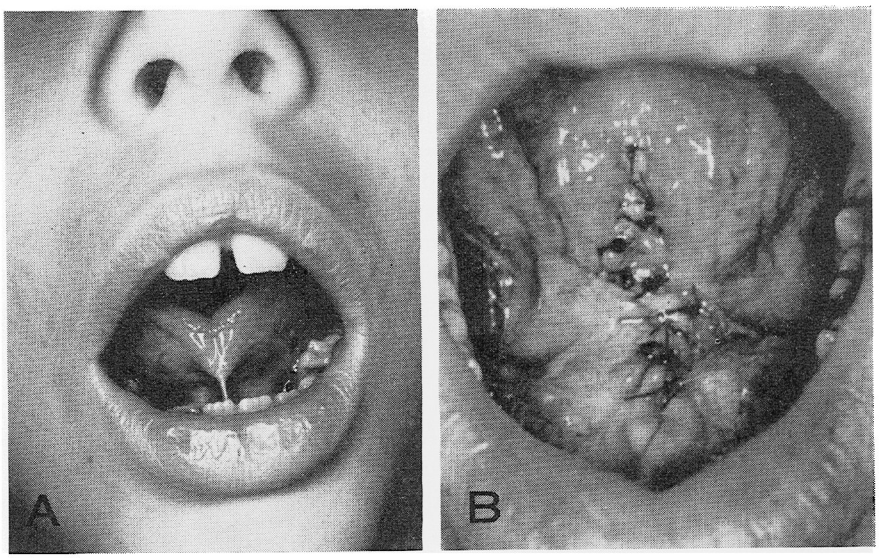

FIGURE 10. *Left,* mild tongue-tie without muscle fibrosis which nevertheless restricts tongue-tip motion. *Right,* free tongue motion restored by frenulectomy and Z-plasty. Since only part of the frenulum was fibrosed a single Z-plasty proved sufficient.

reverse. The triangular Z-flaps are elevated and transposed. The amount of length gained depends on the length of the Z-limbs and on the Z-angle. From a practical standpoint, an angle of 60 degrees gives the largest amount of lengthening under most circumstances. This amounts to an increase of 70 per cent in length. Smaller angles give proportionately smaller degrees of lengthening. When the length of the Z-limbs is limited by the available local tissues, additional lengthening may be obtained by performing two or more Z's. These are usually designed in a parallel series but can also be done in opposite directions.

The operation on tongue-tie is performed under either local infiltration anesthesia or under general endotracheal anesthesia, depending upon the severity of the condition and on the age of the patient. When local anesthesia is used, a preoperative mouth wash with Chloraseptic[2] will help numb mucous membranes and reduce oral fetor. Topical application of Xylocaine Viscous[3] on a cotton pledget to the infralingual structures will further decrease the pain of injection. Even when performed under general anesthesia, we prefer to infiltrate the tissue under and around the frenulum with local anesthetic containing a small amount of epinephrine. The latter causes a local vaso-constriction and helps minimize bleeding. Proper retraction to obtain good exposure

[2] Chloraseptic, a registered trademark of Eaton Laboratories, for a mouth wash containing phenol 1.4%, sodium phenolate, sodium borate, menthol, thymol and glycerine.
[3] Xylocaine Viscous, a registered trade mark of Astra Pharmaceutical Products, Inc.

and good illumination are essential if injury to adjacent nerves, veins and arteries is to be avoided. A heavy suture is passed through the tip of the tongue and used for retraction. The mucosal portion of the frenulum is excised, taking great care not to stray from the midline. Mucosal edges are retracted and the involved fibrosed portions of the underlying genioglossus muscles are divided. Two or more Z-plasties are cut in the mucosa (Figure 9). In cutting the lowermost Z, care must be taken to avoid the ducts and orifices of the submaxillary gland. Z-flaps are elevated by sharp and blunt dissection, and are transposed, sutured in place, and the wound closed with 4-0 chromic catgut. Bleeders encountered during the operation are electrocoagulated or clamped and tied with 5-0 plain catgut.

Postoperatively, a liquid diet is preferred. The mouth is washed with saline after meals and at bedtime. An ice bag to the neck may make the patient more comfortable. Sutures do not require removal and will dissolve spontaneously (Figure 10).

Summary

Tongue-tie, or ankyloglossia, is a condition in which the lingual frenulum is short, thick and fibrosed. Frequently, the fibrosis also involves the underlying genioglossus muscles. When tongue-tie is severe enough to limit free motion of the tip of the tongue, open bite malocclusion and mandibular prognathism may result. Although it does not *cause* speech defects, tongue-tie does *contribute* to difficulties in rate and range of articulation. The centuries-old practice of dividing all lingual frenula and stripping up the tongue has resulted in numerous complications. As a counter-reaction many practitioners refused to consider any surgery for tongue-tie, regardless of severity. In order to help clarify this controversial subject, the pathological tongue-tie is discussed; orthodontic, developmental, speech and other indications for surgical intervention are evaluated. Of all surgical modalities enumerated, only the excision of the thickened frenulum, division of the fibrosed fibers of the genioglossus muscles, and closure of the wound with Z-plasties will produce a successful and permanent correction of the ankyloglossia.

reprints: *Dr. Charles E. Horton*
603 Medical Tower
Norfolk, Virginia 23507

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