

Tongue Tamers for Rapid Open-Bite Closure

JOHN C. VOUDOURIS, DDS, DOrth, MScD
JOHN D. VOUDOURIS

Skeletal and dental anterior open bites are among the most challenging malocclusions not only to diagnose, but to treat and retain in the long term. In an open-bite malocclusion, the tongue thrusts both superiorly and inferiorly, restricting the natural skeletal eruption of the upper and lower anterior teeth.¹⁻¹¹ With simultaneous lateral tongue positioning, the skeletal eruption of the first molars and premolars may also be restricted.

In our investigations of nasal obstruction with Dr. Egil Harvold at the University of Toronto, we found that tongue behavior is highly variable and does not always follow a consistent pattern in anterior open bites. The lower incisors generally tend to be retroclined, as a result of the vertically stretched facial soft tissues and viscoelastic lip forces in patients with muscle hypoactivity and long lower anterior faces. On the other hand, both

the upper and lower incisors can be proclined in some patients, as a result of unnatural, heavy tongue-positioning forces between the incisors. Furthermore, anterior open bite has been associated with maxillary skeletal constriction due to the chronically lower tongue position and stretching of the buccinator muscles and soft-tissue facial mask. Rapid maxillary expansion is often indicated to widen a skeletally constricted palatal suture and to open the nasal passages superiorly. Therefore, several factors associated with open bites need to be addressed with an otolaryngologist or allergist before orthodontic treatment.

Recent studies have employed highly sophisticated methods such as cine-magnetic resonance imaging using real-time balanced turbo field

KRAVITZ KEYS

- ➔ Normal swallowing occurs as many as 1,000 times per day.
- ➔ Aligner Tongue Tamers are perforated, unfilled lingual attachment wells.
- ➔ Rectangular horizontal attachments are placed canine to canine for extrusion and anchorage.
- ➔ Box elastics attached to grooved notches in the aligners are used to promote extrusion.

Dr. Voudouris is a Functional Appliances Instructor, Graduate Department of Orthodontics, University of Toronto, Toronto; a Visiting Scholar, Division of Biological Sciences, New York University, New York; and in the private practice of orthodontics, 2189 Yonge St., Suite 302, Toronto, Ontario M4S 2B2, Canada; e-mail: jvoud@me.com. Mr. Voudouris is a research student, Upper Canada College, Toronto.



Dr. Voudouris



Mr. Voudouris

echo,^{1,2} cine-radiography,^{3,4} ultrasonography,⁵ and cine-fluorography⁶ to study tongue position during swallowing. Normal swallowing occurs 600-1,000 times per day (inclusive of chewing and speaking). In an anterior open bite, the tongue fills the space by anterior tongue positioning (previously referred to as tongue thrusting). The tongue has been found to adapt between the separated and spaced dentition in open bites, moving repeatedly in forward and lateral directions to form an oral seal with a suction effect.^{2,4,6-9} When the dentition is separated—as with chronic nasopharyngeal inflammation associated with allergies, which obstructs the airway and produces secondary mouthbreathing—the posterior molars erupt into the reduced freeway space of the occlusal wedge. Molar extrusion causes the bite to open further in the anterior region, generally in about a 1:1.5 ratio. The forward tongue-tip position can severely affect the upper and lower dental alignment because the powerful tongue contains at least six muscles, but also has the capability of a retraction reflex,¹¹ which has been associated with the prevention of food-bolus aspiration during deglutition.²

Several types of appliances have been developed to control anterior tongue positioning, including traditional cemented tongue cribs and spurs soldered to molar bands^{2,12-17} and bondable habit-breaker brackets on the palatal side of the upper

incisors. These are often bulky, uncomfortable, and cumbersome for patients. In addition, several studies have found tongue cribs to be ineffective habit breakers for digit sucking.¹⁸⁻²⁰ Tongue cribs and habit-breaking devices also require laboratory procedures and separate cementation appointments.

Clear aligners can promote posterior intrusion by means of a bite-block effect in adult anterior open-bite patients. In growing children with anterior open bites, aligners restrict skeletal buccal-segment eruption. We highly recommend a Super-correction Prescription Biomechanics System-6 to prevent relapse from tongue habits in such cases. The six components of this system are:

1. Otolaryngologist
2. Allergist
3. Aligner Tongue Tamer protocol
4. Labial aligner attachments
5. Maxillary expansion
6. Anterior box elastics

Aligner Tongue Tamers

Aligner Tongue Tamers (also called Tongue Trainers) can be programmed directly into the computerized clinical setup and easily perforated at the chair, providing a distinct clinical advantage

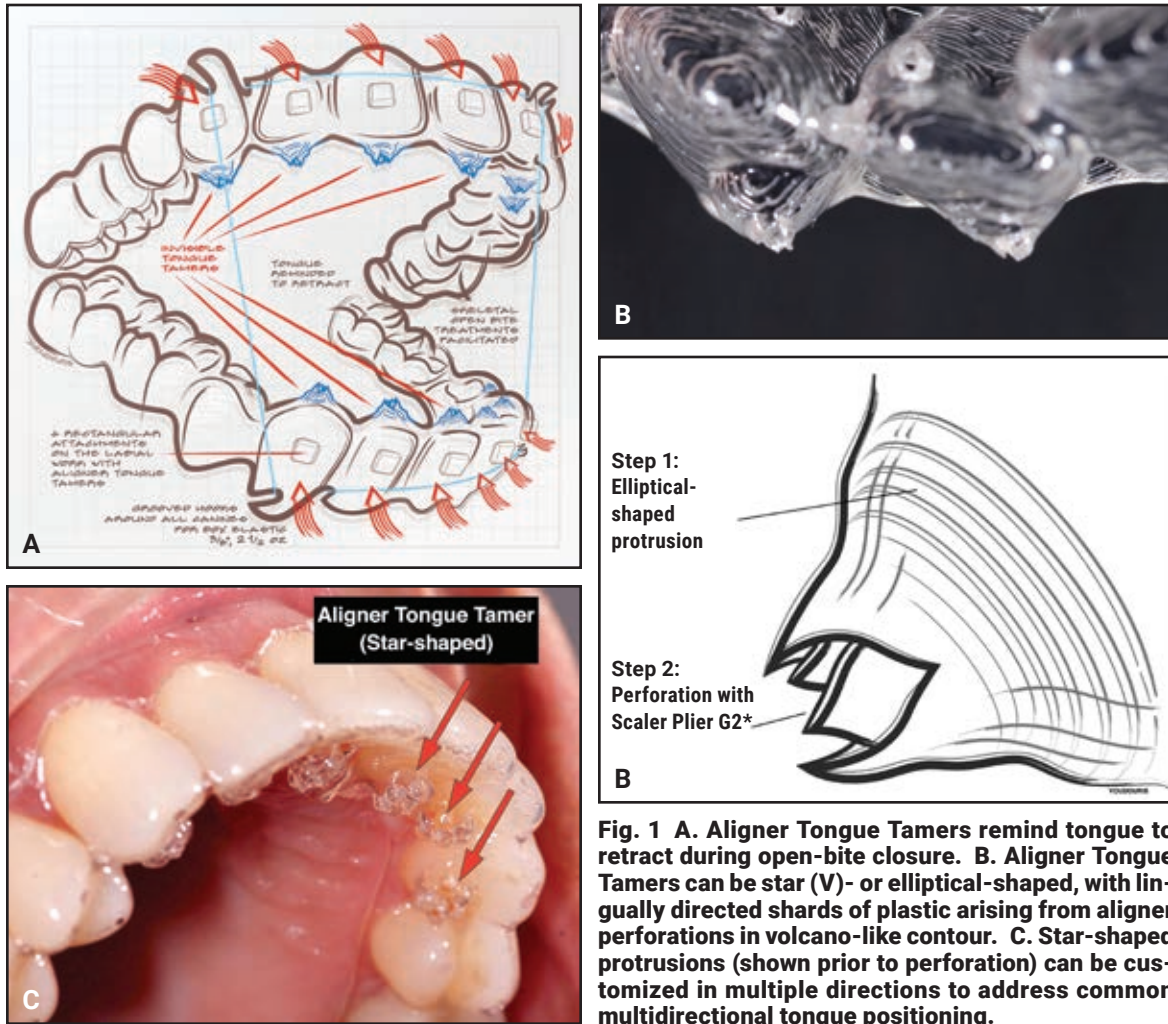


Fig. 1 A. Aligner Tongue Tamers remind tongue to retract during open-bite closure. B. Aligner Tongue Tamers can be star (V)- or elliptical-shaped, with lingually directed shards of plastic arising from aligner perforations in volcano-like contour. C. Star-shaped protrusions (shown prior to perforation) can be customized in multiple directions to address common multidirectional tongue positioning.

(Fig. 1).²¹ Each Aligner Tongue Tamer consists of two parts: a star (V)- or elliptical-shaped protrusion in the plastic and a perforation on top of the most lingual point of each protrusion, creating a volcano-like contour. Clinical trials have shown that perforations without the protrusions are ineffective; the protrusions are required as a first step to move the plastic shards closer to the tongue.

The Tongue Tamers are produced at the chair by perforating the aligner with Scaler Plier G2* plier to produce shards of plastic that will gently prod the tongue in the desired direction (without cutting the tongue or causing pain), thus keeping

the tongue away from the anterior teeth and allowing unobstructed, rapid open-bite closure. For a typical anterior open bite, Aligner Tongue Tamers are placed from upper and lower canine to canine (12 Aligner Tongue Tamer protocol). For a concomitant lateral open bite, the upper premolars and molars are added (18 Aligner Tongue Tamer protocol). Patient accommodation is usually rapid (one to two days).

Twelve labial rectangular horizontal attachments are recommended from upper and lower canine to canine to serve as anchors for further eruption of the maxillary and mandibular anterior

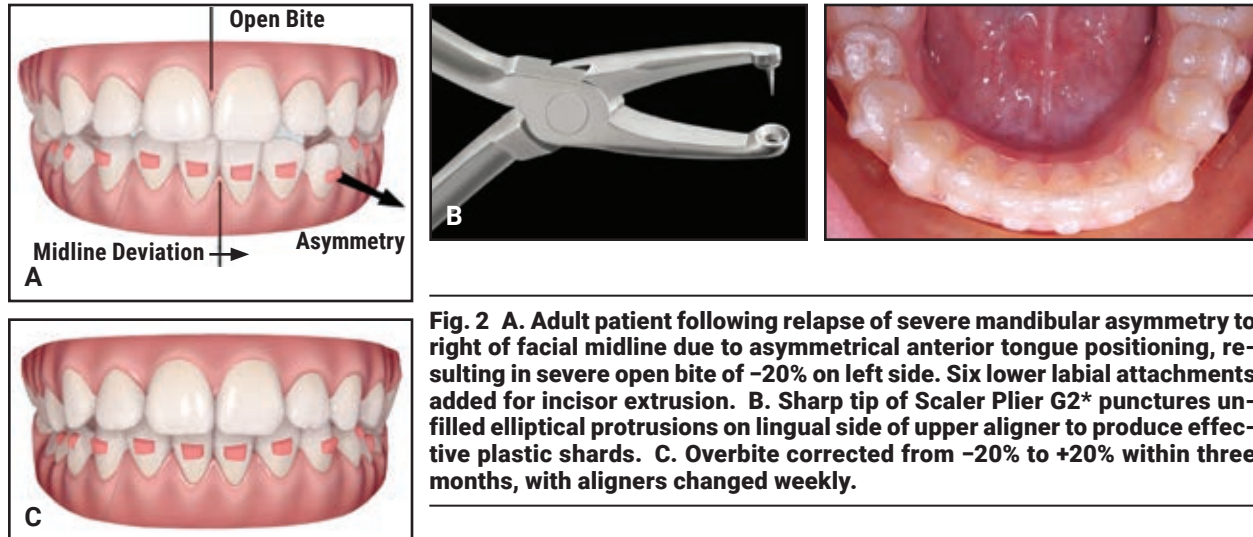


Fig. 2 A. Adult patient following relapse of severe mandibular asymmetry to right of facial midline due to asymmetrical anterior tongue positioning, resulting in severe open bite of -20% on left side. Six lower labial attachments added for incisor extrusion. B. Sharp tip of Scaler Plier G2* punctures unfilled elliptical protrusions on lingual side of upper aligner to produce effective plastic shards. C. Overbite corrected from -20% to +20% within three months, with aligners changed weekly.

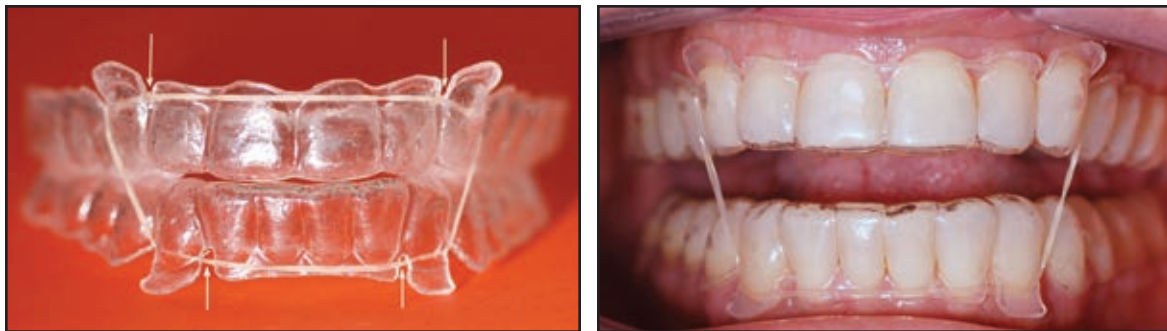


Fig. 3 Box elastic ($\frac{3}{8}$ ", 2.5oz) used with aligners to close open bite.

teeth (Fig. 2). Ideally, the center of the attachment is positioned 2mm gingival to the incisogingival center of the tooth for maximum extrusion. To prevent oral-hygiene issues, including gingivitis, the attachments should not be positioned any closer to the gingiva. A 40% overcorrection of the overbite should be requested in the computerized setup to fully prepare for changes during retention.

Maxillary expansion is also commonly prescribed. The generally lower tongue position associated with secondary mouthbreathing during nasopharyngeal obstruction fails to support the

maxillary arch, thus allowing the buccinator muscles and viscoelastic soft-tissue cheek forces to create maxillary constriction.

A light $\frac{3}{8}$ ", 2.5oz box elastic is recommended, using four grooved notches in the aligners at the upper and lower canines, to facilitate light, continuous extrusion of the upper and lower anterior teeth (Fig. 3). Four smaller grooved notches are added to the distal side of all four lateral incisors to keep the elastic on the labial side of the aligners. These box elastics are commonly required in lateral open-bite cases associated with severe skeletal maxillary constriction (Fig. 4), and they additionally restrict lateral tongue excursions.

*Rocky Mountain Orthodontics, Denver, CO; www.rmortho.com.

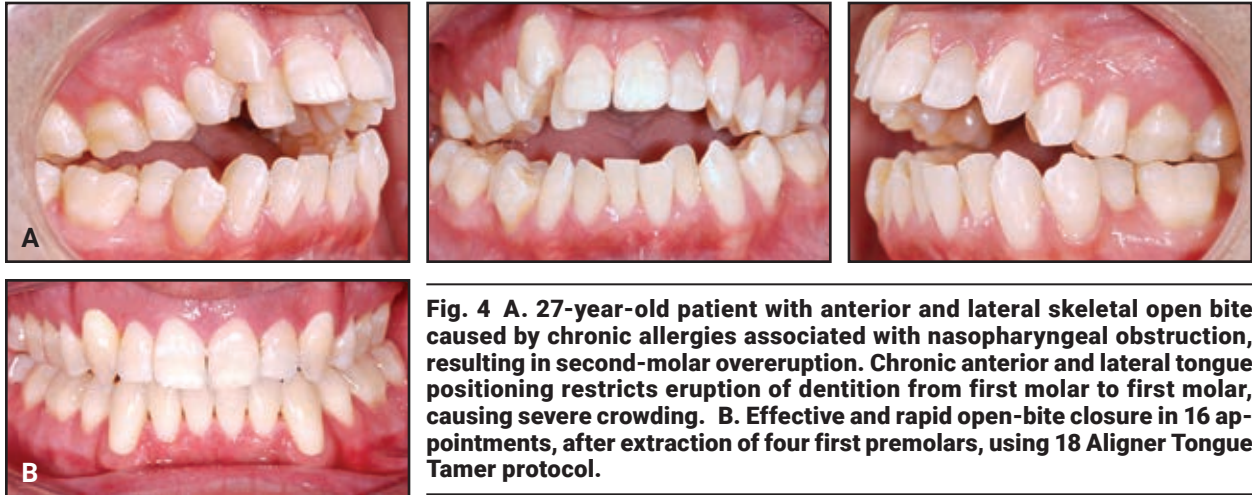


Fig. 4 A. 27-year-old patient with anterior and lateral skeletal open bite caused by chronic allergies associated with nasopharyngeal obstruction, resulting in second-molar overeruption. Chronic anterior and lateral tongue positioning restricts eruption of dentition from first molar to first molar, causing severe crowding. **B.** Effective and rapid open-bite closure in 16 appointments, after extraction of four first premolars, using 18 Aligner Tongue Tamer protocol.

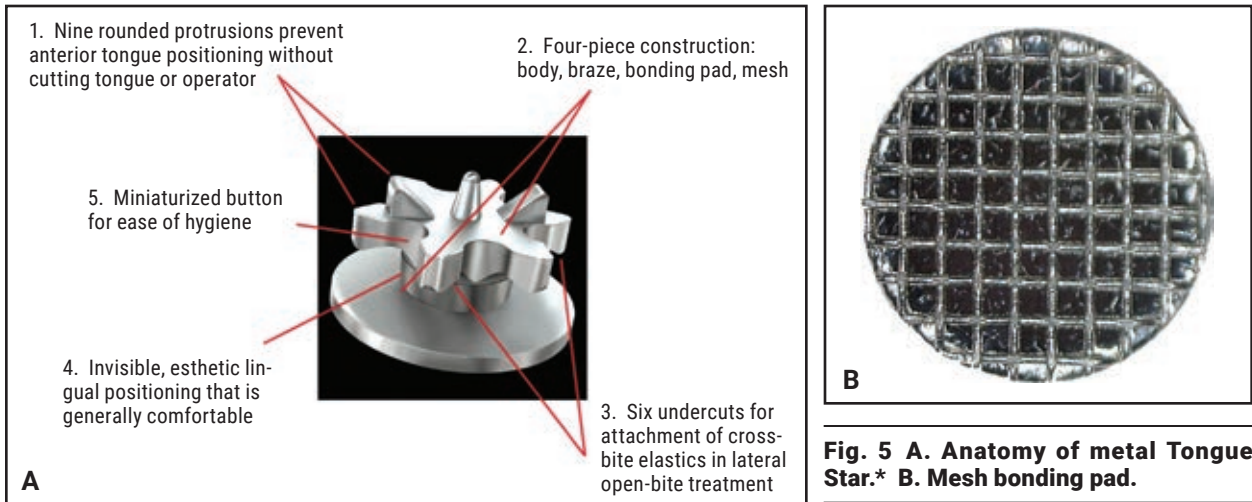


Fig. 5 A. Anatomy of metal Tongue Star.* **B.** Mesh bonding pad.

The aligner protrusions and perforations are repeated at the chair when each aligner is delivered. The protrusions should also be maintained after orthodontic treatment in the long-term aligner retainers.

Metal Tongue Stars

While aligners are increasingly being used in Phase I treatment, a number of patients and parents continue to ask for fixed appliances because of concerns over compliance, impacted teeth, se-

vere rotations, or newly erupting teeth. In these cases, the metal version of Aligner Tongue Tamers, Tongue Stars* (Fig. 5A), become useful.

The first bonded metal Tongue Stars were developed in 2014, using nine reminder protrusions, rounded at the tips, to prevent anterior

*Rocky Mountain Orthodontics, Denver, CO; www.rmortho.com. Also distributed as Tongue Tamers PLUS, registered trademark of Ortho Technology, a subsidiary of Henry Schein Orthodontics, Melville, NY; www.henryschein.com.

**Registered trademark of Sia Orthodontic Manufacturer, Rocca d'Evandro, Italy; www.siaorthodontics.com.

tongue positioning. It was manufactured as a one-piece metal attachment and tested clinically for two years by the author in his private orthodontic practice in Toronto. This first-generation Tongue Star was found to be effective in controlling the tongue and allowing rapid open-bite correction, generally within three months. Modifications were then implemented to reduce the labiolingual profile and improve the bond strength of the first-generation Tongue Star. As a result of this clinical research and development, the second-generation Tongue Star was made as a four-piece unit, including a body with nine rounded protrusions and six new tie-wing undercuts, a braze for occlusal flexibility, a bonding pad, and a separate 80-gauge mesh, which has been used successfully in bracket bases to improve bond strength and resist shearing forces on the palatal enamel (Fig. 5B). To promote patient comfort and oral hygiene, Tongue Stars are similar in size to bondable buttons.

Metal Tongue Stars can be indirectly or directly bonded to the middle thirds of the 12 upper and lower anterior teeth (Fig. 6). The upper Tongue Stars should be positioned 1mm more gingivally to prepare for incisal contact of the corrected upper incisors with the lower incisors during rapid open-bite closure. In cases of lateral open bite, Tongue Stars are added to the upper premolars and molars. In addition, tie-wing undercuts are built into six of the nine side protrusions for attachment of cross-bite elastics (Fig. 7). The elastics can be used early in treatment with a posterior 6 Tongue Star protocol, including Tongue Stars on the upper premolars and first molars.

The ideal time of placement is at the time of bonding a full set of low-profile, active self-ligating twin brackets.* These work synergistically with specialized nickel or beta titanium i-arch wires,**

which have a higher vertical than horizontal dimension (for example, .018" × .014") to be closer to the center of resistance and thus provide earlier incisor moments of torque and the control required for open-bite correction. The brackets' reduced resistance to sliding permits greater freedom of movement within the system, including vertical movement of the upper and lower incisors as the archwires drift posteriorly during anterior dental alignment and open-bite closure. The archwires incorporate a curve of Spee in the lower arch and a reverse curve in the upper arch to further promote incisor extrusion and prevent buccal eruption.

Again, the Tongue Stars should be applied in conjunction with an anterior box elastic, in this case from the labial aspects of the upper lateral incisors to the lower canines to facilitate rapid open-bite closure. Kobayashi hooks are not needed because the tie wings are available for elastic attachment.

Discussion

Aligner Tongue Tamers and metal Tongue Stars produce a negative conditioning reflex response in patients who attempt anterior tongue positioning, similar to a "hot-stove effect," which reduces overall tongue forces on the dentition^{2,22} (Fig. 8). The punctured shards of plastic (Aligner Tongue Tamers) or the rounded ends of the nine metal protrusions (Tongue Stars) will not lacerate the tongue or the operator's glove or skin. The feeling against the finger is one of coarse sandpaper—simply a reminder for the tongue to stay retracted from the open bite. This permits the Tongue Tamers to work effectively in conjunction with the anterior box elastics for rapid open-bite closure. In addition, it is important to instruct the patient to

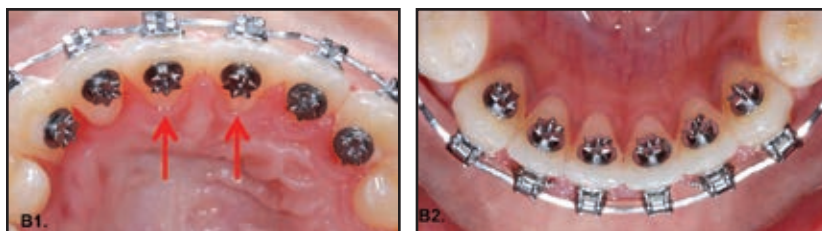


Fig. 6 Tongue Stars bonded lingually to middle thirds of 12 upper and lower anterior teeth. Upper incisor Tongue Stars positioned about 1mm more gingivally (arrows) to prepare for contact with lower incisors following rapid open-bite closure.

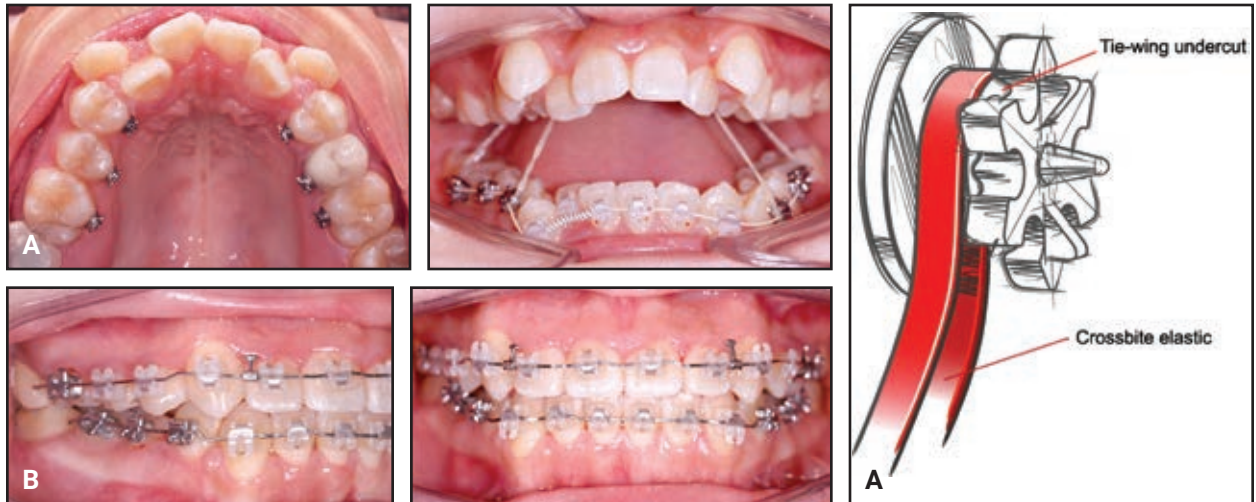


Fig. 7 A. 23-year-old patient with severe open bite, severe crowding, and skeletal maxillary constriction. Tongue Stars initially bonded to upper premolars and first molars for attachment of heavy ¼", 4.5oz crossbite elastics to tie-wing undercuts, promoting maxillary expansion and buccal restriction of lateral tongue positioning. After one month of alignment, anterior Tongue Stars added for full 18 Tongue Star protocol. B. After five months of crossbite correction, second phase involves interproximal reduction and placement of upper low-profile, ceramic active self-ligating brackets* for reduced resistance to sliding on .018" x .014" nickel titanium i-arch wires.**

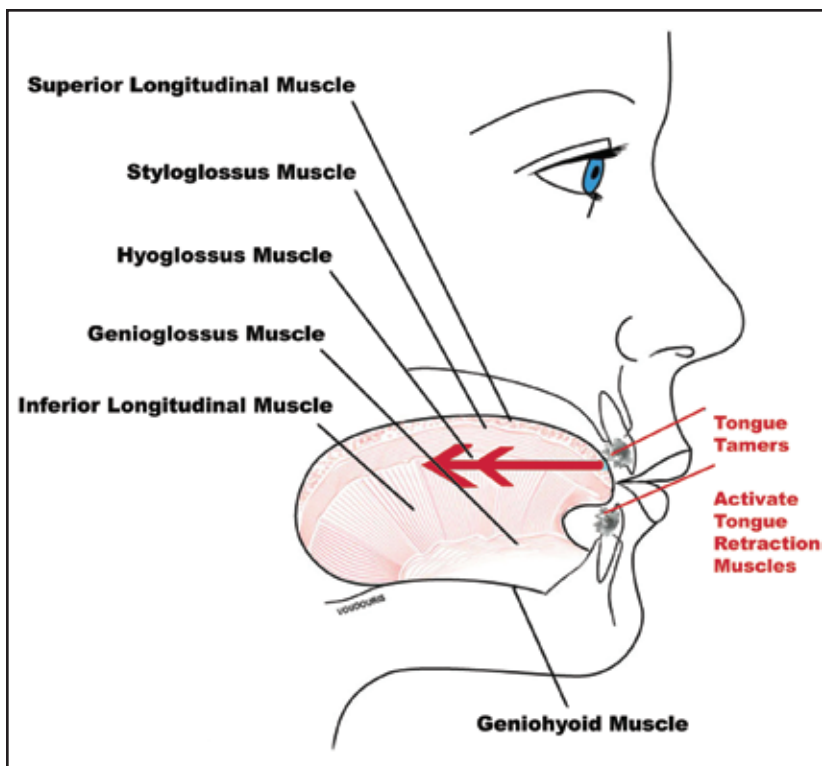


Fig. 8 Retraction reflex mechanism from Aligner Tongue Tamers or metal Tongue Stars. Tongue retracts to prevent aspiration of food bolus during deglutition.

practice swallowing with the tongue in the roof of the mouth from the first day of placement.

Aligner Tongue Tamers and metal Tongue Stars can be used in all age groups, including early interceptive treatment. Once the incisors begin to develop a positive overbite relationship, the tongue can begin to retract posteriorly into a more natural position, with reduced force during deglutition. This assumes that the critical etiology of the open bite—such as nasopharyngeal obstruction—has been at least considered and ideally controlled. A 1% saline nasal spray used once or twice per day is a good natural anti-inflammatory.

As the anterior open bite is corrected, it is important to monitor the Aligner Tongue Tamers' incisal shards of aligner plastic or the protrusions of the Tongue Stars for the potential need to reduce them with a high-speed green stone or diamond bur, thus preventing dental interference. The objective is to overcorrect the overbite to be greater than 40% before retention.^{23,24} In the long term, open bites are associated with downward and backward mandibular growth and consequently have a guarded to poor prognosis. With proper diagnosis and treatment planning, however, the open-bite correction from tongue retraction appliances can be maintained in long-term retention.

REFERENCES

- Akin, E.; Sayin, M.O.; Karaçay, S.; and Bulakbaşı, N.: Real-time balanced turbo field echo cine-magnetic resonance imaging evaluation of tongue movements during deglutition in subjects with anterior open bite, *Am. J. Orthod.* 129:24-28, 2006.
- Sayin, M.O.; Akin, E.; Karaçay, S.; and Bulakbaşı, N.: Initial effects of the tongue crib on tongue movements during deglutition: A cine-magnetic resonance imaging study, *Angle Orthod.* 76:400-405, 2006.
- Fujiki, T.; Inoue, M.; Miyawaki, S.; Nagasaki, T.; Tanimoto, K.; and Takano-Yamamoto, T.: Relationship between maxillofacial morphology and deglutitive tongue movement in patients with anterior open bite, *Am. J. Orthod.* 125:160-167, 2004.
- Fujiki, T.; Takano-Yamamoto, T.; Noguchi, H.; Yamashiro, T.; Guan, G.; and Tanimoto, K.: A cineradiographic study of deglutitive tongue movement and nasopharyngeal closure in patients with anterior open bite, *Angle Orthod.* 70:284-289, 2000.
- Peng, C.L.; Jost-Brinkmann, P.G.; Yoshida, N.; Miethke, R.R.; and Lin, C.T.: Differential diagnosis between infantile and mature swallowing with ultrasonography, *Eur. J. Orthod.* 25:451-456, 2003.
- Cleall, J.F.: Deglutition: A study of form and function, *Am. J. Orthod.* 51:566-594, 1965.
- Proffit, R.W. and Fields, H.W.: *Contemporary Orthodontics*, 3rd ed., Mosby, St. Louis, 2000, pp. 135-137.
- Subtelny, J.D.: Malocclusions, orthodontic corrections and orofacial muscle adaptation, *Angle Orthod.* 40:170-201, 1970.
- Subtelny, J.D. and Subtelny, J.D.: Oral habits—studies in form, function, and therapy, *Angle Orthod.* 43:349-383, 1973.
- Cheng, C.F.; Peng, C.L.; Chiou, H.Y.; and Tsai, C.Y.: Dentofacial morphology and tongue function during swallowing, *Am. J. Orthod.* 122:491-499, 2002.
- Ramford, S.P. and Major, M.A.: *Occlusion*, W.B. Saunders, Philadelphia, 1971, pp. 42, 89-91.
- Huang, G.J.; Justus, R.; Kennedy, D.B.; and Kokich, V.G.: Stability of anterior openbite treated with crib therapy, *Angle Orthod.* 60:17-24, 1990.
- Fränkel, R. and Fränkel, C.: A functional approach to treatment of skeletal open bite, *Am. J. Orthod.* 84:54-68, 1983.
- Haryett, R.D.; Hansen, F.C.; Davidson, P.O.; and Sandilands, M.L.: Chronic thumb-sucking: The psychologic effects and the relative effectiveness of various methods of treatment, *Am. J. Orthod.* 53:569-585, 1967.
- Haryett, R.D.; Hansen, F.C.; and Davidson, P.O.: Chronic thumb-sucking: A second report on treatment and its psychological effects, *Am. J. Orthod.* 57:164-178, 1970.
- Erverdi, N.; Küçükkeles, N.; Arun, T.; and Biren, S.: Cephalometric evaluation of crib therapy for cases of mixed dentition (open bite), *J. Nihon Univ. Sch. Dent.* 34:131-136, 1992.
- Villa, N.L. and Cisneros, G.J.: Changes in the dentition secondary to palatal crib therapy in digit-suckers: A preliminary study, *Pediat. Dent.* 19:323-326, 1997.
- Subtelny, J.D. and Sakuda, M.: Open-bite: Diagnosis and treatment, *Am. J. Orthod.* 50:337-358, 1964.
- Cooper, J.S.: A comparison of myofunctional therapy and crib appliance effects with a maturational guidance control group, *Am. J. Orthod.* 72:333-334, 1977.
- Epker, B.N. and Fish, L.: Surgical-orthodontic correction of open-bite deformity, *Am. J. Orthod.* 71:278-299, 1977.
- Thiesen, G.: Inclusion of tongue spurs in clear aligners, *J. Clin. Orthod.* 54:429-430, 2020.
- Cooper, S.: Muscle spindles in the intrinsic muscles of the human tongue, *J. Physiol.* 122:193-202, 1953.
- Voudouris, J.C. and Voudouris, J.D.: *Supercorrection Prescription Aligner Mechanics*, Dentofacial Orthopedic Publications, Toronto, 2022, pp. 1-60.
- Voudouris, J.C.; Voudouris, J.D.; Nicolay, O.; Glaser, B.; Nicozisis, J.; Theodoridis, G.; Carrillo, R.; Moshiri, M.; and Masoud, M.: Clear aligners, dentofacial orthopedics, physics and supercorrection prescription biomechanics: A meeting of the minds, *Semin. Orthod.* 27:202-258, 2022.

*Rocky Mountain Orthodontics, Denver, CO; www.rmortho.com.

**Registered trademark of Sia Orthodontic Manufacturer, Rocca d'Evandro, Italy; www.siaorthodontics.com.