



Muscle Memory: A Review of Tongue Muscles, and its Functions and Dysfunctions

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Muscle Memory: A Review of Tongue Muscles, and its Functions and Dysfunctions

EDUCATIONAL OBJECTIVES

At the conclusion of this educational activity, participants will be able to:

1. Review the muscles of the tongue muscles, including their origin, insertion, and function.
2. Recognize a healthy oral rest posture.
3. Identify restrictions, functional obstacles, and habits that may be contributing to poor tongue function/movement.
4. Understand the role of the tongue in orofacial development, breathing, speech, and digestion.
5. Know when to integrate other medical and dental professionals for treatment of tongue muscle dysfunction.

ABSTRACT

How do most clinical dental professionals look at the tongue on a daily basis? Likely when inspecting the tongue is part of a standard oral cancer exam. Visually examining and palpating the dorsal, ventral, lateral boards of the tongue and looking for any abnormalities on the surface, ideally should be completed at every dental exam.¹ Is this where exploring the tongue ends for most dental professionals? Are dental professionals looking at the function of the tongue? Could there be other clues that the tongue is providing into a view of the patient's overall health?

This article will review the muscles of the tongue as an organ and its function in daily activities, like breathing, speech, and digestion.² We will discuss the tongue's role in orofacial growth, development and overall health. Also, learning when and to what health care professional to should refer patients for help in correcting tongue dysfunction or poor oral habits.



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INTRODUCTION

A sometimes difficult question for one to answer is ‘where does your tongue normally rest or sit?’ Oral rest posture of the tongue, however, can be important in many everyday functions of the tongue including healthy breathing, speech, digestion, and more. Why is a tongue resting where it is? This article will review the tongue muscles and help dental professionals understand more about healthy tongue posture.

TONGUE MUSCLE REVIEW

The tongue is made up of eight individual muscles, four intrinsic and four extrinsic. The tongue can also be divided into two halves, which connect at the midline of the tongue. On the ventral side of the tongue, the midline is called the median septum. On the dorsal side this is referred to as the median lingual sulcus. The base of the tongue is located near the top of the pharynx or medial in the body while anteriorly is the body, followed by the apex or tip.³

The intrinsic tongue muscles have both their origin and insertion points on the inside of the tongue. Intrinsic muscles have no attachments to bone.⁴ These muscles are named for their orientation in the body. Function of these muscles involves fine motor control to transform the shape of the tongue. Intrinsic muscles will move the tongue from short and wide to long and thin, along with curling the lateral boarders.³

Intrinsic muscles include the superior longitudinal, which runs the length, base to apex, on the dorsal surface of the tongue and the inferior longitudinal which runs the length of the ventral surface of the tongue. The transverse muscle stretches horizontally from the median septum to the lateral boarder. The vertical muscle spans vertically from ventral to dorsal sides.³

The extrinsic muscles of the tongue insert into the body of the tongue but all have different origins that connect the tongue to surrounding structures. Extrinsic muscles are used during lateral, horizontal, protruding and retracting movements of the tongue.⁵ These muscles work together to move the tongue body as a whole.⁴ Extrinsic muscles are key contributors of the movements needed in mastication and speech.

The genioglossus origin is from the genial

tubercles on the anterior portion of the mandible. Its insertion is on both the hyoid muscle and along most of the ventral surface of the tongue. Encompassing two separate insertion points makes this muscle have a fan-shaped appearance. The genioglossus helps with protrusion and some depressing the tongue. It anterior origin deflects the tongue from falling to far back into the pharynx so to not block the airway.³

The hyoglossus originates from the hyoid bone and inserts into the lateral boarders of the tongue. This muscles assists in depressing the tongue.³

The styloglossus has an origin stemming from the styloid process of the temporal bone. The insertion is at two different points of the lateral boarder of the tongue, one near the apex of the tongue and the other near the base of the tongue. This muscle is used during the superior and posterior retraction of the tongue.³

Lastly, the palatoglossus muscle originates from the median palatine raphe, making up the anterior faucial pillar. It inserts into the lateral boarders of the tongue. This muscle aids in the act of swallowing by raising the tongue to meet the soft palate to create a seal during the swallow. Depending on the text book, this muscle is included into either the tongue muscles, the soft palate muscles, or both.³ This article includes it into tongue muscles because it has an insertion into the lateral boarders and helps to activate the tongue’s movements during the swallow.

ORAL REST POSTURE

Before diving into dysfunctions of the tongue, it is important to understand where a tongue and the surrounding oral structures should be positioned at rest for the most proper and healthy tongue function. Hanson and Mason thoroughly describe the aspects of a healthy oral rest posture including where teeth, lips, and tongue should properly be resting.⁶

First, freeway space, the distance separating the maxillary and mandibular teeth in the resting position. Freeway space should consist of a separation between maxillary and mandibular teeth of two to three millimeters in the posterior and two to five millimeters in the anterior.⁶

Second, a healthy oral rest posture, which includes lips that are gently and effortlessly

touching one another.⁶ This encourages nasal breathing and lips act as an outward muscular force against teeth. More about breathing and muscular forces will be discussed later in this article.

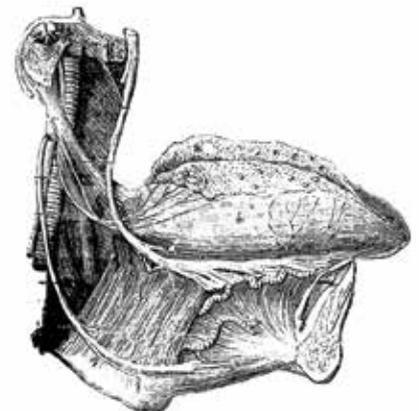
Finally, the tongue’s proper resting position, the apex of the tongue should be resting just lingual to the maxillary anterior teeth and on the incisive papilla of the hard palate⁵. The lateral boarders of the tongue should be resting along the maxillary alveolar ridge.⁶ Proper tongue position will aid in clear and easy speech, as well as, healthy digestion, both discussed later in this article.

Poor oral rest posture occurs when a tongue is no longer resting against the maxilla or hard palate. The tongue may be resting between the teeth, sitting along the floor of the mouth, positioned between the maxilla and mandible, or pushing out anteriorly or laterally.⁵

ANKYLOGLOSSIA

Ankyloglossia is defined as “an abnormally short, thick, fibrosed” tissue on the ventral side of the tongue². Ankyloglossia comes from two Greek words; ‘akylosis’ meaning fixed in place and ‘glossa’ meaning tongue. This is commonly and frequently referred to as a “tongue-tie” or “tethered oral tissue” (TOT). The origin of the term tongue-tie seems to remain unknown.⁷ Tongue-tie is the term we will use throughout this article.

The organ known as the tongue begins to form in week four to five of pregnancy. By week ten, the tongue muscles are still developing, but begin to separate away from the floor of the mouth. The ectodermal tissue that housed the tongue until this point diminishes



so that the tongue can begin to freely move about. A complete separation does not always occur which can lead to a restriction in tongue mobility at the sublingually, ranging anywhere from a slight to rather severe restriction.⁷ Tongue-ties are seen in four to eleven percent of newborns.⁸ Tongue-ties are said to be more prevalent in females by a three to one ratio.⁹ These are often found due to inadequate breastfeeding, including painful nipple irritation for the mother.⁸

Tongue-ties may be noticed at birth or anytime throughout life, but are often noted at birth by reason of breastfeeding complications with infant and/or mother.² Problems

with breast feeding, speech articulation, orthodontic malocclusion, open bite, craniofacial abnormalities, drooling, or trouble with food clearance when eating are all possible concerns stemming from an associated tongue-tie. These issues are often looked at as separate, unconnected events of a growing child which can lead to a missed tongue-tie diagnosis.¹⁰

REVISIONS OF TONGUE-TIE

Now the question is, what to do about a tongue-tie? According to Chinnadurai, et al. "Some propose that a short frenulum will elongate spontaneously with progressive

stretching and thinning of the frenulum with age and use, and thus no treatment is necessary. However, there are no prospective longitudinal data to support this assertion."¹⁰

Due to advances in laser technology, lasers are frequently used in tongue-tie frenectomies today. One of the lasers that may be used is a carbon dioxide (CO₂) laser, which is used for many types of oral soft tissue resection procedures. A CO₂ laser is considered a rapid and safe treatment of tongue-tie, with minimal bleeding or wound complications. This can be completed with local anesthesia infiltrated into the frenum.¹¹ Another type of laser that can be used in a frenectomy procedure is an erbium, chromium-doped yttrium, scandium, gallium and garnet (Er,Cr:YSGG) laser.¹² A third type of laser is the diode laser which is frequently used by dentists in frenectomies and other dental procedures.¹³ Like the CO₂ laser, the Er,Cr:YSGG and diode lasers also have little to no bleeding, pain, or scarring, and requires minimal local anesthesia.^{12,13} Operators often use local anesthesia but may also opt to use solely a topical anesthesia, still with minimal pain involved.⁹

Both scalpel blades and electric scalpels are used for this procedure but leave a higher risk of excess bleeding and more often than not require suture placement. This in turn, will increase the time of the procedure.¹¹ Placing a sublingual suture may prove to be difficult on a patient whom is not under general anesthesia for the procedure, especially an infant or young child.

O'Shea, et al, completed a study of frenotomies on over 300 newborn babies under three months of age and concluded there were no adverse outcomes following the procedure. This study found a reduction in mother's nipple discomfort. However, this study did not follow up with the families on the long-term basis too look at the successfulness of long term breastfeeding and future tongue function.⁸ The *American Family Physician*, a medical journal, published a study of infant frenotomies and breastfeeding correlations concluding patient and family evidence of success but limited scientific indication.¹⁴ In a study of older children, the only detriment noted on day of procedure was minimal bleeding at the surgical site that stopped quickly.¹⁰



POOR ORAL HABITS

Prolonged thumb, finger, tongue, or pacifier sucking, and tongue thrusting can be considered poor oral habits. Many parents, grandparents, teachers, or others may have tried to discourage a child from sucking on a thumb, finger, or pacifier. Is there something more to a poor oral habit than just the negative appearance that most people associate with these habits? Sucking habits can cause the tongue to rest in a low position causing a poor oral rest posture even when the sucking is not occurring, becoming a habitual position for the patient.

A distinction between infantile suckling and a sucking habit should firstly be differentiated so not to cause confusion between the two. From as early as week thirteen of pregnancy and for many months post birth, suckling can be observed regularly. Suckling, or the act of using facial and tongue muscles in sucking to sooth (non-nutritive) or to achieve milk from a mother's breast or a bottle (nutritive), is an infant reflex that will begin to diminish around twelve months.¹⁵

A sucking habit can include the non-nutritive sucking of any single or multiple of the following: thumb, finger(s), tongue, lip, pacifier, blanket, or shirt.^{6,16} A sucking habit is sometimes retained into later childhood as a soothing mechanism from an emotional or past traumatic experience the child may have encountered, examples would be birth of another sibling, losing a parent, lack of stability, or abuse.⁶

Non-nutritive sucking under the age of three years tend to have little permanent effects associated with them. Incisors may be pushed forward, but should be resolved with proper muscular forces from lips and cheeks when non-nutritive sucking habits arrest.¹⁵ When non-nutritive sucking habits continue past age three a more permanent, but still most often reversible, damage begins to occur. The interference of the item being sucked on prevents the tongue from resting against the palate. A sucking habit can lead to a high and narrow vault in the palate. This will occur because buccal and lip muscles are at normal force yet the tongue is not reciprocating the forces back.^{16,17}

Lip sucking can be included into non-nutritive sucking habits and over a long period of time can interrupt the structure

of the jaw bones, causing malformation of the maxilla or mandible¹⁶. Tongue sucking is noted frequently, but not exclusively, in children and adults with Down syndrome.¹⁷

Tongue thrusting is the act of the tongue pushing forward against the teeth forcibly when swallowing. A tongue thrust during swallowing, however forceful, will not alone cause an open bite. The pressure of the tongue is great and thousands of swallows are completed each day, but the need for consistent pressure for longer periods of time must occur for a tongue to change the periodontal structures. Tongue thrusting should be concerning for a low rest posture

is likely present. A low oral rest posture could be the result from a missed tongue-tie or a past or present sucking habit.¹⁸

Treatments for an open bite and a poor oral rest posture should include sucking habit elimination to restore as much of the healthy, wide growth pattern of the hard palate without intervention when possible. An orofacial myofunctional therapist is specialized in regaining a proper oral rest posture by teaching the tongue muscles where they should be at rest and during a swallow. Orofacial myofunctional therapy (OMT) is used in conjunction with orthodontics to gain the most benefit for obtaining a spacious oral cavity.¹⁹



(This is the same patient as the above pictures, these were taken two days post laser frenectomy)

ROLE OF THE TONGUE IN OROFACIAL DEVELOPMENT

During the fifth week of pregnancy, a primordial plate begins to form a separation between the oral and nasal cavities. By week twelve, the bone of the hard palate begins fusing together at the median palatine suture. This creates a more distinctive separation of the oral and nasal cavities, as the maxilla forms. A stronger fusion of the maxilla bones is likely completed by 12 months after birth.²⁰ However, throughout childhood this bone still has the ability to grow with the child. "By age six, your child will have achieved most of [their] skull growth and approximately 80% of [their] jaw growth."²¹ Many orthodontists agree that expansion of the palate is possible until approximately age twelve when there is a more permanent end to the growth patterns of these bones. Although, in recent years there have been new techniques made available to gain some expansion of maxilla bones in teens and adults.¹⁶

A more natural and lifelong expander could be considered the forces exerted from the tongue muscles intraorally, along with reciprocation of buccal muscles extraorally. This occurs when the tongue is in proper position against the hard palate. When the tongue is laying in a position away from the hard palate, the buccal muscles to force the maxilla into a more narrow position.¹⁶

Excess freeway space, more than the ideal two to three and two to five millimeters posteriorly and anteriorly, respectively, can have a negative impact on the forces that the tongue muscles put on the teeth. This can be seen with an incorrect tongue posture occurring in one of two ways. Firstly, the tongue can be pushed forward, sitting between anterior teeth and causing over-eruption of posterior teeth. This creates an anterior open bite. Secondly, the tongue can be sitting back and low, with the mouth hanging open. This creates a posterior cross-bite because the buccal muscles will generate forces inwardly and that are not being reciprocated by the forces of the tongue muscles against the palate, outwardly.¹⁸

Outward facial appearances of a person can be considerably different when a person has a wider and flatter palate than a high vaulted palate. The person with the high

vaulted palate will appear narrow or long in their forehead and nose, have closer set eyes, and possibly a mandible that is set either too far forward or back. This differs from a wider set palate in a more round shaped facial appearance that can be evenly visualized in equal one-thirds with invisible lines at the eyebrows and nose. Wider jaws will also align teeth more properly.²¹ Always take into account ethnic variations in dissection of outward facial appearance.¹⁷

ROLE OF THE TONGUE IN BREATHING

As described in a healthy oral rest posture, ideally, the majority of resting throughout day and night time should include lips that are closed, gently touching one another. Trevisan, et al. showed that mouth breathing adults used less accessory inspiratory muscles during rapid inspiration, in turn lowering the total air capacity in the lungs compared to rapid inspiration with nasal breathing.²² Nasal breathing increases the health of the inspiration of air by warming the outside air temperature and increases the humidity of the air entering the body, as well as, aiding in removing bacteria and other material.²³ Nasal breathing is ideally occurs when the lips are sealed together.

When the lips are habitually separated and mouth breathing is primary form of breathing, it is important to find out why this is happening. The habitual lips apart, mouth breathing appearance is commonly not exclusively a tongue function issue. Increased mouth breathing may be a necessity for the patient if there is inflammation in the nasal passages. A patient should be evaluated for enlarged palatine tonsils, adenoids, or allergies by an otolaryngologist or ears, noses, and throat (ENT) doctor.²³

When the maxilla is forced into a more narrow position with a low tongue posture, the nasal cavity is also forced into a more narrow form decreasing oxygen brought into the body and carbon dioxide leaving the body. Often this can lead the head into a more forward position, with an open mouth, to increase the airway space.¹⁶

ROLE OF THE TONGUE IN SPEECH

A tongue-tie may interfere with speech articulation, heard by way of consistent difficulty with specific sounds or difficulty of speech

during specific situations (i.e. speaking loudly, hurriedly or when tired or whispering).²⁴ However, a tongue-tie doesn't trigger the speech problems but simply restricts the tongue's movement making sounds more difficult to make and understand. Removal of the restriction and exercise with speech therapy should resolve most cases.⁷ The younger the patient, especially age three and below, speech issues due to tongue-ties may resolve with little to no speech therapy needed.²⁴

A social concern of some patients with tongue muscle dysfunction is excess salivation while speaking. The saliva may pool and not be swallowed efficiently and can come out during speech causing embarrassment.²⁴

Fatigue of the tongue muscles during speech in patients with diseases such as Parkinson's disease can be observed. One study showed that tongue muscle fatigue while speaking sentences was more significant in those with Parkinson's disease than in a control group.²⁵ However, this study noted that there was minimal difference between the disease and control groups in fatigue during syllable repetition activities. With diseases or situations where function may not be able to be restored, professionals should use caution to make the patient's feel understood and not embarrassed with the speech difficulty.

ROLE OF THE TONGUE IN DIGESTION

With the gradual loss of the suckling reflex and the introduction of solid foods, the tongue shifts how it's used during meals. The tongue goes from sitting below a nipple to force milk upward and out, to raising to the palate to aid in swallow the food.¹⁵ The tongue also aids in the production of salivary flow. It also helps to mix the food into the saliva to begin the digestive breakdown process. With a good lip seal and a majority nasal breathing pattern during mastication, the tongue makes the food into a bolus for easy swallowing with minimal air ingestion.⁷ Once the initial swallow of the food bolus is completed, the tongue should complete a sweep around the buccal sides maxillary and mandibular posterior teeth to insure that no food is remaining. Those with a tongue-tie may not be able to complete this extra sweep with the tongue and may have to use fingers to clear excess food from around

the teeth. If food is not cleared away, risk of caries developing in these areas increases⁵.

Finger swiping to clear food may be one indication of an interference of the tongue's function while eating. Other signs may include frequent drinking during meals to help clear food and create moisture, noisy chewing, chewing with mouth open, and even food aversions to crunchy foods that may be more difficult to chew and swallow.²⁵ A discussion with the patient or their family members may lead to a referral to other health care professionals including orofacial myofunctional therapist, orthodontist, ENT, or speech therapist.

CONCLUSION

As dental professionals, we should be able to recognize tongue muscle dysfunctions in our patients. It's important to understand that these dysfunctions caused by a tongue-tie or a sucking habit can affect how the patient's face grows, breathing, speech, and digesting their food. Research and speaking with other local professionals that may be involved in your patient's overall health care will increase the practitioners knowledge in these type cases and aid in earlier diagnosis and referral when appropriate. Having a referral system with medical doctors, speech therapists, orofacial myofunctional therapists, orthodontists and other dentists all having knowledge about the effects of tongue muscle dysfunctions will only benefit our patients in the long term.

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QUESTIONS

1. **What muscle is can be considered both a tongue and soft palate muscle?**
 - a. Styloglossus
 - b. Palatoglossus
 - c. Intrinsic
 - d. Hyoglossus
2. **What is the tissue called that is left behind to form the lingual frenum?**
 - a. Striated muscle
 - b. Smooth muscle
 - c. Primordial tissue
 - d. Ectodermal tissue
3. **At what time does suckling begin?**
 - a. In utero
 - b. At birth
 - c. When breastfeeding ends
 - d. When breast and bottle feeding ends
4. **Which is not used to perform a frenectomy?**
 - a. Electric scalpels
 - b. CO₂ laser
 - c. Cathode laser
 - d. Diode laser
5. **What muscles are attached to no bones?**
 - a. Striated
 - b. Smooth
 - c. Intrinsic
 - d. Extrinsic
6. **Which tongue muscle has two insertion points, making it into a fan shaped appearance?**
 - a. Hyoglossus
 - b. Styloglossus
 - c. Palatoglossus
 - d. Genioglossus
7. **Which is not a sign of poor tongue function during swallowing.**
 - a. Frequent drinking with eating
 - b. No drinking with eating
 - c. Chewing with open mouth
 - d. Noisy chewing
8. **_____ may come out during speech causing embarrassment to a person.**
 - a. Salvia
 - b. Food
 - c. Tongue
 - d. Bad breath
9. **Freeway space should be _____ in the anterior and _____ in the posterior.**
 - a. 3 mm; 3 mm
 - b. 0-3 mm; 0-1 mm
 - c. 2-5 mm; 2-3 mm
 - d. 1-3 mm, 0-1 mm
10. **Extrinsic tongue muscles all insert into the tongue but have different _____.**
 - a. Origins
 - b. Actions
 - c. Processes
 - d. Functions
11. **Which is not a situation where speech articulation may be in jeopardy?**
 - a. Speaking loudly
 - b. Speaking quickly
 - c. Speaking slowly
 - d. Speaking when tired.
12. **It is beneficial for a patient to see a _____ when inflammation may be blocking nasal breathing.**
 - a. Orthodontist
 - b. Dental Hygienist
 - c. Sleep Doctor
 - d. Otolaryngologist
13. **Nasal breathing increases _____ being brought into the body?**
 - a. Bacteria
 - b. Temperature of air
 - c. Brain cells
 - d. Carbon Dioxide
14. **What kind of sucking should be strictly stopped after 12 months old?**
 - a. Non-nutritive
 - b. Nutritive
 - c. Both A and B
 - d. Neither A or B
15. **Tongue and _____ muscles act as a natural expander for the maxilla**
 - a. Facial muscles
 - b. Nasal bones
 - c. Both A and B
 - d. Either A or B
16. **Which part of the tongue touches the hard palate naturally:**
 - a. Base
 - b. Dorsal surface
 - c. Genioglossus
 - d. Ventral surface
17. **Under what age does a sucking habit have to be stopped to have little permanent effect on the oral cavity?**
 - a. Under 12 months
 - b. Under 3 years
 - c. Under 12 years
 - d. Under 18 years
18. **According to one study, tongue-ties have a 3:1 ratio of being greater in _____.**
 - a. Females
 - b. Males
 - c. Infants
 - d. Orthodontic patients

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EXPIRATION DATE:	JULY 2021

Muscle Memory: A Review of Tongue Muscles, and its Functions and Dysfunctions

Name: _____ Title: _____ Specialty: _____

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Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 3 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. **For Questions Call 800-633-1681**

EDUCATIONAL OBJECTIVES

- Review the muscles of the tongue muscles, including their origin, insertion, and function.
- Recognize a healthy oral rest posture.
- Identify restrictions, functional obstacles, and habits that may be contributing to poor tongue function/movement.
- Understand the role of the tongue in orofacial development, breathing, speech, and digestion.
- Know when to integrate other medical and dental professionals for treatment of tongue muscle dysfunction.

COURSE EVALUATION

1. Were the individual course objectives met?

Objective #1:	Yes	No	Objective #2:	Yes	No
Objective #3:	Yes	No	Objective #4:	Yes	No

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0
8. Please rate the usefulness and clinical applicability of this course.	5	4	3	2	1	0
9. Please rate the usefulness of the supplemental webliography.	5	4	3	2	1	0
10. Do you feel that the references were adequate?			Yes		No	
11. Would you participate in a similar program on a different topic?			Yes		No	

12. If any of the continuing education questions were unclear or ambiguous, please list them.

13. Was there any subject matter you found confusing? Please describe.

14. How long did it take you to complete this course?

15. What additional continuing dental education topics would you like to see?

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