Tip of the tongue diagnosis: Tongue signs in neurological diseases

Diagnóstico na ponta da língua: Sinais da língua em doenças neurológicas

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ABSTRACT

The tongue is a crucial organ with multiple roles in speech, taste, and overall oral function. Its complex anatomy and rich innervation make it an important site for detecting signs of systemic and neurological diseases. This review examines the various clinical signs observable on the tongue, which can aid in diagnosing a range of neurological conditions. We focus on the motor and sensory abnormalities, structural changes, and involuntary movements that may present in the tongue, highlighting their diagnostic value in identifying conditions such as motor neurone diseases, nutritional deficiencies, and systemic infections. Despite its clinical importance, the examination of the tongue is often overlooked in neurological assessments. By synthesizing relevant findings from a broad literature review, this study emphasizes the necessity of a thorough tongue examination as an integral component of neurological evaluations. Understanding these signs can improve diagnostic accuracy and facilitate appropriate patient management.

Keywords: tongue, tongue examination, movement disorders, neurology, neurological diseases

RESUMO

A língua é um órgão crucial com múltiplas funções na fala, no paladar e no funcionamento oral geral. Sua anatomia complexa e rica inervação fazem dela um local importante para detectar sinais de doenças sistêmicas e neurológicas. Esta revisão examina os diversos sinais clínicos observáveis na língua, que podem auxiliar no diagnóstico de uma série de condições neurológicas. Focamos nas anormalidades motoras e sensoriais, nas mudanças estruturais e nos movimentos involuntários que podem se manifestar na língua, destacando seu valor diagnóstico na identificação de condições como doenças do neurônio motor, deficiências nutricionais e infecções sistêmicas. Apesar de sua importância clínica, o exame da língua é frequentemente negligenciado nas avaliações neurológicas. Ao sintetizar descobertas relevantes de uma ampla revisão da literatura, este estudo enfatiza a necessidade de um exame minucioso da língua como parte integrante das avaliações neurológicas. Compreender esses sinais pode melhorar a precisão diagnóstica e facilitar o manejo adequado dos pacientes.

Palavras-chave: língua, exame da língua, distúrbios do movimento, neurologia, doenças neurológicas.

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INTRODUCTION

The tongue, a small muscular organ in the base of the mouth, is much more intricate than meets the eye. Its pivotal role in many of life's essential functions, such as feeding, breathing, and speech, is made possible by a sophisticated anatomy that lies in the interface of the neurological, gastrointestinal, and respiratory systems.[1]

The tongue has many functions. It has motor functions that are precise enough to articulate different phonemes during speech, coordinate swallowing, and even whistle and mimic other animals. It also has refined sensory inputs that project to large cortical areas, making it the part of the body in which the smallest distance between two points can be distinguished. At the same time, it is the place where the special sensation of gustation - the subjective experience of taste derived from the chemical composition of foods - is first processed. Due to this wide range of functions, many signs of disease might manifest in the tongue.

The tongue comprises 30 muscles, divided into intrinsic muscles (longitudinal, transverse, and vertical muscles) and extrinsic muscles (such as hyoglossus, styloglossus, genioglossus, and geniohyoid). The motor nerve that supplies all tongue muscles is the Hypoglossal Nerve (Cranial Nerve 12). Corticobulbar fibers from the precentral gyrus mediate the supranuclear control of the tongue, and the input to all tongue muscles is bilateral, except for the genioglossus, which is crossed. The tongue has a fold of mucous membrane called frenulum in its base, which anchors the tongue in the mouth and stabilizes its movements.[2, 3]

On its surface, the tongue has connective tissue papillae that contain the taste buds, the receptors of gustatory sensation (carried by the facial nerve on the anterior two-thirds of the tongue and by the glossopharyngeal nerve in the posterior third). These inputs go to the rostral solitary nucleus in the medulla before ascending to the hemispheres.[3]

The somatic sensation of the tongue is supplied by the trigeminal nerve in its branch V3. The proprioceptive sensation goes to the trigeminal mesencephalic 'nucleus, the touch sensation goes to the principal trigeminal nucleus on the pons, and pain and thermal sensations go to the spinal nucleus of the trigeminal nerve on the medulla and upper spinal cord.[3]

For neurologists, tongue examination is essential to detect signs of primary neurological diseases and signs that might point to systemic diseases affecting the nervous system, providing valuable shortcuts for diagnosing diseases and determining their mechanisms. The tongue is a privileged spot for clinical examination since it is easily accessible and visible without needing tools other than a flashlight. Its examination should comprise inspection for structural abnormalities and involuntary movements, motor examination for loss of power and deviations, and special and somatic sensory examination for taste disorders or sensory abnormalities such as hypesthesia or pain.

Despite the abundance of tongue signs described in various neurological disorders, there is a notable absence of a comprehensive review of these signs in a single article or book chapter. This narrative review aims to fill this gap. We have made a broad literature review on tongue signs relevant to neurological disorders and will present these signs according to the part of the examination they are presented in - inspection, motor, sensory, and neuroimaging findings. A summary of these signs can be found in Table 1.

METHODS

A broad narrative literature review was conducted by searching PubMed, Cochrane, and Google Scholar for articles and books about the examination of the tongue and its clinical findings. Inclusion criteria were signs and syndromes relevant to the clinical diagnosis of diseases with prominent neurological manifestations. Tongue disorders related to diseases with minor or no neurological findings were excluded.

RESULTS

INSPECTION FINDINGS

Atrophic glossitis

Atrophic glossitis refers to the partial or complete absence of filiform papillae on the dorsal surface of the tongue, usually associated with deficiency states such as riboflavin, niacin, pyridoxine, vitamin B12, folic acid, iron, zinc, and vitamin E.[4]

This sign can be helpful when evaluating patients with neurological manifestations related to nutritional deficiencies. In vitamin B12 deficiency, patients may present with peripheral neuropathy, subacute combined degeneration of the spinal cord, cognitive impairment, and sometimes optic neuropathy.[5] In vitamin B1 deficiency, patients may present with Wernicke's encephalopathy (characterized by the triad of truncal ataxia, ocular abnormalities, and encephalopathy), Korsakoff syndrome (an amnestic confabulatory syndrome), and peripheral neuropathy. Patients with vitamin E deficiency may present with a spinocerebellar syndrome with dorsal column involvement and peripheral neuropathy.[1]

Tongue Ulcers

Ulcers, defined as disruptions in skin integrity, emerge when surface skin cells perish and are sloughed off. Tongue ulcers can indicate various systemic disorders, encompassing infections, cancers, and inflammatory

disorders. In the context of neurological symptoms, they may hint at specific conditions such as secondary Syphilis, HIV, and Behçet's disease.[6]

Patients with secondary Syphilis may present with meningovascular Syphilis, causing strokes, cranial nerve deficits, and headaches.[7] Patients with HIV may present with neurologic syndromes due to direct HIV complications, such as HIV-associated neurocognitive disorders, HIV myelopathy, and peripheral neuropathy, or complications related to opportunistic infections, such as progressive multifocal leukoencephalopathy or fungal or tuberculous meningitis.[8,9] Behçet disease may present with neurological manifestations in approximately 10% of cases, usually related to cerebral venous thrombosis or parenchymal disease that can cause brainstem disease, encephalopathy, myelopathy, or optic neuropathy.[10]

Fissured tongue

Fissured tongue refers to grooves in the tongue that can vary in location and size. It can occur in idiopathic fashion and on deficiency states, but it has also been associated with specific syndromes, such as Melkersson Rosenthal, Down Syndrome, and Allgrove syndrome.[11]

Melkersson-Rosenthal syndrome is a disease characterized by the classical triad of orofacial edema, infranuclear (unilateral) facial paralysis, and fissured tongue.[12] Allgrove or 3A syndrome is a hereditary condition characterized by the triad of adrenal insufficiency, alacrimia, and achalasia.[11]

Atrophic tongue

Loss of the muscle bulk of the tongue may be observed in different neurological disorders. It is most commonly the result of a lower motor neuron lesion, usually a consequence of motor neuron disease (such as Amyotrophic Lateral Sclerosis, Spinal Muscular Atrophy and Kennedy disease) or hypoglossal neuropathy. Tongue atrophy is also found in Parry-Romberg syndrome (along with hemifacial atrophy), and in Moebius syndrome (along with nuclear abducens and/or facial palsy).[11]

Fasciculations

Fasciculations are spontaneous and intermittent contractions of muscle fibers that are usually seen in the context of lower motor neuron disorders affecting the muscles of the tongue, such as motor neuron diseases (Amyotrophic Lateral Sclerosis, Spinal Muscular Atrophy, and Kennedy disease), Poliomyelitis and Post-Polio syndrome or hypoglossal neuropathy.[11]

Triple-furrowed tongue

The triple-furrowed tongue refers to a distinctive pattern of tongue atrophy, described by Buzzard in 1905, in which a midline and two parallel longitudinal grooves appear in the tongue. It is a rare sign in patients with Myasthenia Gravis. Despite being most common in patients with anti-MuSK antibodies, it is also reported in acethylcholine receptor-positive patients.[13, 14]

Self-inflicted traumatic lesions

Bites, lacerations, and mutilation of the tongue can point to disease processes such as motor seizures, psychiatric disorders, bruxism, and some movement disorders.

Motor epileptic seizures can cause biting of the tongue, usually in its lateral aspect. This contrasts with the tongue biting that can occur during non-epileptic psychogenic episodes, usually at the tip of the tongue.[11]

Also, some movement disorders affect the orofacial region and may characteristically cause tongue lacerations and mutilations, such as Lesch Nyhan Syndrome (X-linked recessive disorder characterized by developmental delay, chorea, spasticity and self-mutilating behaviors), and chorea-acantocitosis (recessive disorder characterized by chorea, orolingual dystonia and acantocytes in the peripheral blood smear in the late stages of the disease).[15, 16]

Tongue necrosis

Necrosis of the tongue is a rare occurrence, usually related to lingual malignancy, use of vasoconstrictor drugs, or radiation. However, it can also be an uncommon sign of r cell arteritis.[17]

Giant cell arteritis is a large vessel vasculitis that can cause fever, weight loss, headache, jaw claudication, and a variety of ocular syndromes, most notably ischemic optic neuropathies.[17, 18]

Macroglossia

Macroglossia refers to long-term painless tongue enlargement and can occur in a wide range of hereditary or acquired diseases that can present neurological symptoms.[11]

Hereditary causes of macroglossia include Down syndrome, a chromosomal disorder characterized by dysmorphic facial features, intellectual disability, and early development of Alzheimer's disease, and Mucopolysaccharidoses, lysosomal storage disorders that

can cause a wide range of symptoms, including skeletal abnormalities and intellectual deficiency, and some cases of hereditary muscular dystrophies. Some other congenital pathologies involving macroglossia result from jaw underdevelopment, leading to a "relative macroglossia," as seen in patients with Pierre Robin syndrome.[11, 19, 20]

Acquired causes of macroglossia include Amyloidosis (which can present with peripheral neuropathy and dysautonomia), acromegaly (which can present with compressive neuropathies), myxedema (which can present with a wide range of neurological symptoms such as coma cognitive impairment, peripheral neuropathy, delayed relaxation of reflexes, myopathy and movement disorders).[11, 21, 22]

Furthermore, cases of macroglossia secondary to neurosurgical procedures and direct trauma to the tongue, as in post-epileptic episodes, have been documented.[11, 23]

Discoloration of the tongue

Unilateral hairlike discoloration of the tongue can occur in patients with ipsilateral trigeminal neuralgia due to hypertrophy of the filiform papillae that occurs in the absence of mechanical stimulation on that side because of pain triggering.[24]

MOTOR FINDINGS

Tongue deviations

Lateral deviations

Lateral deviations when protruded the tongue can be a sign of many different conditions.

- Upper motor neuron lesions

Unilateral lesions affecting the corticonuclear pathway to the hypoglossus nucleus may cause contralateral tongue deviation when protruding due to weakness of the contralateral genioglossus. If the lesion also affects corticospinal pathways, there is a concomitant contralateral limb weakness – making the tongue deviate to the same side of the hemiparesis.[25]

- Lower motor neuron lesions

Unilateral lesions of the motor neurons that]comprise the hypoglossal nucleus may cause ipsilateral tongue deviation when protruded. When the lesions occur in the brainstem, the patient can present with a crossed syndrome, such as in Dejerine's Syndrome (ipsilateral tongue palsy with contralateral hemiparesis) or the complete hemimedullary syndrome of Reinhold (ipsilateral tongue palsy, Horner syndrome, paralysis of lower motor neurons of 9th and 10th cranial nerves, crebellar ataxia, hypoesthesia of the face and contralateral hemiparesis and hypoesthesia of the trunk and limbs).[26, 27]

The hypoglossal nerve can be damaged at any point of its length, in isolation or combined with other cranial nerves. The main causes of isolated hypoglossal palsy are intracranial neoplasms, skull base neoplasms, trauma and cervical artery dissection.[28]

When the hypoglossal is damaged along with other cranial nerves, the combination may point to the pathology site. Classical syndromes are:

- Godfredsen syndrome – Cranial nerve XII and VI. Localizes to clivus lesions.[29]
- Collet-Sicard syndrome – Cranial nerves IX, X, XI, and XII. Localizes to the jugular foramen along with the hypoglossal channel.[30]
- Villaret Syndrome – Cranial nerves IX, X, XI, XII, and a Horner's syndrome. Localizes to the retropharyngeal space (encompassing the jugular foramen, the hypoglossal channel and the cervical sympathetic trunk).[31]
- Tapia Syndrome – Cranial nerves X (recurrent laryngeal nerve branch) and XII. Localizes to lesions in the upper cervical region.[32, 33]
- Garcin Syndrome – Involvement of at least seven cranial nerves, which may include the Cranial Nerve XII. Localizes to the skull base.[34]

- ''Wrong way'' deviations

Cases of functional hemiparesis may present the wrong way tongue deviation sign – in which the patient deviates the tongue to the opposite side of the hemiparesis. This can be accompanied by tonic deviation of the tongue.[26]

Tongue dysarthria

Motor affections of the tongue may cause difficulty in the articulation of some phonemes such as /l/, /d/, and /t/ during speech, without impairment of language functions.[35, 36]

Involuntary movements

- Tongue tremor

Tremor is defined as an involuntary, rhythmic, and oscillatory movement of a body part.[37]

Resting tongue tremors, with or without reemergence when the tongue is protruded, can occur in Parkinson's disease and other parkinsonian syndromes, such as Progressive Supranuclear Palsy.[11, 38]

A postural tremor with the tongue protruded may

occur in patients with essential tremor (usually accompanied by the characteristic postural tremor of the hands) and has been previously described in other conditions such as Neurosyphilis, Neurofascin-155 related Polyradiculapthy and left frontal lobe stroke.[37, 39, 40]

- Tongue Chorea

Chorea is a hyperkinetic movement disorder characterized by involuntary brief, random, and irregular contractions conveying a feeling of restlessness to the observer.[11]

Choreiform movements, usually associated with motor impersistence of the tongue, sometimes referred to serpentine movements, can occur Huntington's Disease, an autosomal dominant disease characterized by progressive development of choreiform movements, dementia and psychiatric disorders. Chorea in the face and the tongue can also occur in patients with the dyskinetic form of Cerebral Palsy, a group of conditions characterized by permanent nonprogressive neurological deficits due to fetal or infant brain development abnormalities, and tardive dyskinesia resulting from long-term use of neuroleptics and other antidopaminergic drugs.[11, 37, 41-43]

- Tongue Dystonia

Dystonia is a movement disorder characterized by sustained or intermittent muscle contractions causing abnormal, often repetitive movements, postures, or both.[13]

Dystonia affecting the tongue may occur in patients with Chorea-Acanthocytosis and Lesch Nyhan Syndrome as previously mentioned.[11, 44]

- Tongue myoclonus

Myoclonus is a clinical sign characterized by brief, shock-like, involuntary movements caused by muscular contractions or inhibitions.[45]

Tongue myoclonus has been described as occurring in an essential idiopathic form in ALS and with some cases of palatal myoclonus (usually caused by lesions within the Guillain-Mollaret triangle).[46, 47]

- Galloping or Undulating tongue

The galloping tongue is a hyperkinesia characterized by episodic involuntary, wave-like rhythmic movements. This condition has already been observed in patients with Wilson's Disease, patients with paroxysmal kinesigenic dyskinesias with mutations in the PRRT2 gene, and even in patients with ALS.[11, 48, 49]

- Trombone tongue

Repetitive protrusion-intrusion movements of the tongue, named trombone tongue, have been associated with medullary compression. [50]

Tongue myotonia

Myotonia refers to impairment of relaxation of skeletal muscles after voluntary contraction. Some muscle diseases that cause myotony can also affect the tongue, such as in Myotonic Distrophy type 1 (Steinert Disease).[51]

SENSORY FINDINGS

Loss of superficial sensation

Lesions of the V3 segment of the trigeminal nerve can cause loss of superficial sensation on the anterior two-thirds of the tongue, sometimes accompanied by bursts of neuropathic pain (Trigeminal Neuralgia). A similar clinical picture may occur with lesions of the Glossopharyngeal nerve, in which loss of sensation of the posterior third of the tongue is often unnoted. However, bursts of neuropathic pain triggered by swallowing may lead to significant impairment of feeding. Lesions affecting these nerves may range from idiopathic causes to secondary ones such as vascular compression of the nerve, inflammatory disease of the central nervous system (in the root entry zone), intraoral and peritonsillar infections, intracranial mass lesions, posterior fossa and cervical malformations and oropharyngeal cancer. [52,53]

Neck tongue syndrome

The "neck tongue syndrome" refers to a syndrome of nuchal pain and ipsilateral tongue paresthesias triggered by cervical spine movements. It is usually caused by subluxation of the posterior atlantoaxial joint and C2 spinal root compression.[54, 55]

Burning mouth syndrome

Burning mouth syndrome or glossodynia is an intraoral burning sensation without a medical or dental cause. Pain may be restricted to the tongue or just the anterior third of the tongue. The cause is not yet well established, but some authors suggest it to be a form of small fiber neuropathy. [56]

Taste disorders

Taste disorders are much less common than other special sensory disorders and are very difficult to detect in the clinical setting, especially if they are partial. Lesions that affect taste sensation may lead to hypogeusia or ageusia in the affected territory. The main reasons are local causes such as bad mouth hygiene, smoking, and dry mouth. Lesions of the facial nerve before the emergence of the Chorda Tympani branch may lead to loss of taste sensation in the ipsilateral anterior two-thirds of the tongue. Lesions of the Glossopharyngeal nerve may lead to loss of taste sensation in the ipsilateral posterior third of the tongue, which is very difficult to assess. Rarely, lesions in the brainstem that affect the nucleus of the solitary tract may cause loss of ipsilateral taste sensation, such as in Wallenberg's Syndrome.[57, 58]

NEUROIMAGING FINDINGS

Hyperdense tongue sign on T1

The hyperdense tongue sign can be observed during T1-weighted magnetic resonance imaging. This finding results from chronic tongue denervation and consequent muscle tissue replacement by adipose tissue. It can be found in patients with Amyotrophic Lateral Sclerosis, Kennedy's Disease, and certain myopathies, particularly POMPE Disease. It has also been described in Oculopharyngeal Muscular Dystrophy, Myotonic Dystrophy Type 1 (Steinert's Disease), and Facio-Scapulo-Humeral Muscular Dystrophy.[25]

Large tongue with increased signal

The increase in volume and percentage of fat in the tongue can be observed in patients with Obstructive Sleep Apnea, reducing the organ's strength and impairing the dilation of the upper airways.[11]

CONCLUSION

The tongue is at the interface of the cutaneous, neurological, and gastrointestinal systems and, therefore, can be affected by many diseases. The clinician can detect early signs of nutritional deficiencies, infections, genetic conditions, and many systemic and neurological diseases by performing simple inspection and motor and sensory examinations of the tongue. Integrating a comprehensive tongue examination into general medical assessments can be a valuable tool to enhance diagnostic accuracy and facilitate timely patient interventions.

Table 1. Tongue signs and associated conditions.

Table 1. Tongue signs and neurological associated conditions	
Atrophic glossitis	Deficiency states, such as riboflavin, niacin, pyridoxine, vitamin B12, folic acid, iron, zinc, and vitamin E
Tongue ulcers	Secondary Syphilis, HIV, and Behçet's disease
Fissured tongue	Deficiency states, Melkersson Rosenthal, Down syndrome, and Allgrove syndrome
Tongue atrophy and fasciculations	Lower motor neuron lesions (motor neuron diseases, hypoglossal neuropathy, Parry-Romberg Syndrome, Moebius syndrome)
Triple-furrowed tongue	Myasthenia Gravis
Bites, lacerations and mutilation	Epileptic seizures, non-epileptic seizures, Lesch-Nyhan syndrome, Chorea-Acanthocitosis
Focal necrosis	Giant Cells Arteritis
Macroglossia	Down syndrome, Mucopolysaccharidoses, Amyloidosis, Acromegaly, Myxedema
Lateral deviation when protruded	Upper motor neuron lesions (contralateral), lower motor neuron lesions (ipsilateral), or functional weakness ('wrong way' deviations)
Tongue tremor	Essential tremor, Parkinson's disease, other parkinsonian disorders
Tongue chorea	Huntington's disease, Tardive diskinisia, Cerebral palsy
Tongue dystonia	Chorea-Acanthocytosis and Lesch Nyhan syndrome
Tongue myotonia	Myotonic myopathies, Myxedema
Episodic pain	Trigeminal neuralgia, Neck-Tongue syndrome
Loss of superficial sensation	Trigeminal neuropathy (V3) by compression, inflammatory or infectious disorders, or lesions of the brainstem (such as multiple sclerosis or stroke)
Ageusia	Local causes (bad mouth hygiene, smoking, dry mouth), facial nerve lesions (ipsilateral anterior two thirds), glossopharyngeal nerve lesions (ipsilateral posterior third) or lower brainstem lesions that affect the nucleus of the solitary tract)

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