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REVIEW ARTICLE

Investigations for diseases of the tongue: A review

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Abstract

Tongue is a vital organ within the oral cavity that has varied function, and it may act as an index for underlying systemic diseases. The investigation of tongue disease may begin with mere clinical examination and extend to the use of few specialized tests. This article is an attempt to highlight the special investigations of tongue lesions with emphasis on clinical examination.

Introduction

Oral cavity is the most important structure of the orofacial complex and has hard and soft tissues, each of which has a varied anatomy and function. It mainly acts as a source for communication of the internal body with the outside environment. Among these tissues, tongue is a mobile muscular organ situated in the floor of the mouth which can assume a variety of shapes and positions in the oral cavity. A thorough examination of the tongue is an integral part of the physical examination and may provide clues to the systemic conditions; nevertheless, it has been the most neglected organ with in the zone of interest. This article emphasizes on the importance of clinical examination of the tongue and the available special investigations for early diagnosis and management of tongue disorders. Routine hematological investigations are mandatory for the initial assessments of any diseases of the tongue which helps in the identification of underlying health status. However, describing them in detail is beyond the scope of this article.

Tongue develops from the first branchial arch in the 4th week of intrauterine life and has various functions such as speech, mastication, deglutition, and taste. There are various disorders that may be manifested on the tongue, and among them, the common disorders can be broadly grouped into various categories.

Working classification of common disorders of tongue is shown in Table 1.

The examination of the tongue is an integral part in oral screening of diseases, and the steps of clinical examination of tongue are discussed below.

Clinical Examination of the Tongue

A good illuminating light and mouth mirror are the main requirements for the examination of the intraoral structures. Initially, an overall assessment should be made of entire oral mucosa, then begin with examination of dorsum and lateral margins of the tongue followed by the ventral surface, ask the patient to protrude the tongue, and move sideways and then examine. Tongue is to be stabilized with the cotton/gauze and should be examined for changes of color, shape, size, and surface of tongue using both direct and indirect vision [Figures 1 and 2]. Depress the tongue using the tongue depressor to observe similar changes in the base of the tongue and the circumvallate papillae.

Other changes like swellings , ulcers, fissures, atrophy or hypertrophy of papillae should be noted. Ulceration of the mucosa of the tongue may be due to trauma, infection, immune-related disease, or neoplastic. Vesiculobullous blistering disorders frequently also present as ulceration due to rupture of initial lesions. Any physiological or pathological changes should be noted. Using a gloved hand palpation should be done, hold the tongue with gauze in one hand, and palpate the tongue

Table 1: Working classification of common disorders of tongue

Developmental disturbances	**Traumatic lesions of tongue**	**Infections of tongue**
Aglossia	*Physical*	*Bacterial*
Microglossia	Tongue piercing	Tuberculosis
Macroglossia	Linea alba	Syphilis
Ankyloglossia	Scalloped tongue	Scarlet fever
Fissured tongue	Traumatic ulcer	*Fungal*
Bifid tongue	*Chemical*	Candidiasis
Median rhomboid glossitis	*Thermal*	*Viral*
Benign migratory glossitis		
Hairy tongue		
Lingual thyroid nodule		
Lingual varices		

Immunological conditions of tongue	**Cysts of tongue**	**Potentially malignant disorders of tongue**
Recurrent aphthous stomatitis	Dermoid/ Epidermoid	Leukoplakia
Lichen planus	Lymphoepithelial	Erythroplakia
Pemphigus vulgaris	Gastric mucosal cyst	Lupus erythematous
	Mucous cyst	Syphilitic glossitis

Neoplastic

Benign	**Malignant**	**Systemic conditions associated with glossitis**
Fibroma	Squamous cell carcinoma	Iron deficiency anemia
Giant cell fibroma	Verrucous carcinoma	Pernicious anemia
Glomus tumor	Kaposi's sarcoma	Niacin deficiency
Leiomyoma	Angiosarcoma	Folic acid deficiency
Rhabdomyoma	Mucoepidermoid carcinoma	
Plasmacytoma	Malignant lymphoma	
Neurofibroma	Malignant melanoma	
Keratoacanthoma		
Papilloma		
Adenoma		
Hemangioma		
Lymphangioma		

Syndrome associated with tongue	**Taste disorders**	**Miscellaneous lesion**
Aglosia–adactylia syndrome	Ageusia	Lichenoid reaction
Beckwith–Wiedemann syndrome	Hypogeusia	Pyogenic granuloma
Burning Mouth syndrome	Hypergeusia	Dyskeratosis
Down syndrome	Dysguesia	
Eagles syndrome		
Melkersson–Rosenthal syndrome		
Orofacial digital syndrome		
Parry–Romberg syndrome		
Riley–Day syndrome		

between the thumb and index finger of the other hand (bidigital palpation technique). The tissues of the tongue should feel soft and resilient with no palpable indurations or masses.

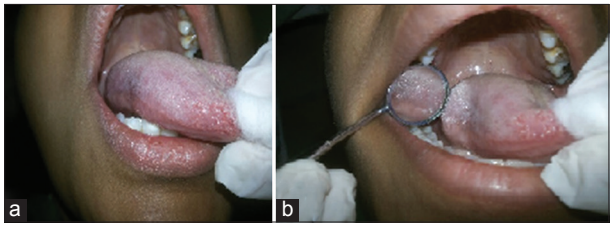

Figure 1: Clinical examination: (a) Direct vision method, (b) Indirect vision method

Evaluation of Nerve Supply

Tongue is supplied by motor and sensory components of 5th, 7th, 9th, 10th, and 12th cranial nerves. Taste sensation and the other functions of the facial nerve are not routinely tested, but altered taste, lacrimation, and salivation history are taken while recording the case details. For formal taste testing, measurement of detection or recognition thresholds is done. The detection threshold is the lowest concentration at which a taste can just be detected while the recognition threshold is the lowest concentration at which the quality of a taste stimulus can be recognized and few other tests can be carried out to assess the taste function.[1]

Magnitude matching

It is an psychophysical procedure where assessment is done based on the patient's perceptions of various concentration of taste intensities above threshold level (concentrations of sodium chloride, sucrose, quinine hydrochloric acid, and citric acid) along with various loudness levels (up to 1000 Hz) tone which are provided for the magnitude matching task. The patient sips each solution and expectorates, and the tones are presented through headphones. The patient estimates and gives a value for perceived magnitude for each stimulus. The results are scaled in relation to loudness functions to reveal abnormalities of taste as depressed psychophysical functions.[2] Patients with hypogeusia associate stronger taste concentrations with weaker tones than normal patients. The limitation of this test is its dependence on normal hearing and its complicated design.

Spatial test

The gustatory system has multiple nerve innervation, and damage to one of the three major nerves or their ganglia may cause a disturbance of taste that can be evaluated only by testing the anatomic areas supplied by those nerves. To test these areas, filter paper (4 standardized sizes) are soaked with strong concentrations of the four basic tastes. The papers are randomly placed on the all quadrants of the tongue and on both sides of the soft palate. Patients then identify the quality of the taste and rate its intensity from 1 to 10 (10 being the strongest).[3]

Labeled magnitude scale

"Three drop test" given by Henkin[4]

In this test, three drops of liquid are presented to the patient. One of the drops is the taste stimulus, and the other two drops

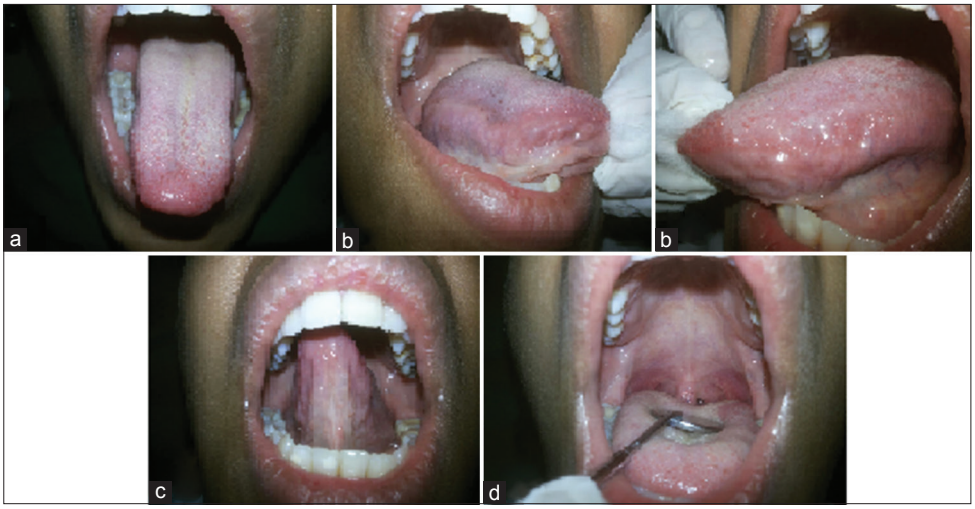

Figure 2: Surfaces of the tongue: (a) Dorsal, (b) right and left lateral surfaces, (c) ventral (d) base

are of pure water. The threshold is noted at the concentration where the patient identifies the taste correctly 3 times in a row.

Motor nerve examination

The hypoglossal nerve provides motor innervation to the intrinsic and extrinsic muscles of the tongue. The examiner begins to assess the tongue movements by asking the patient to open their mouth and inspecting the tongue for wasting and fasciculations (rippling, involuntary movements of a muscle at rest) while it is at rest in the floor of the mouth. Then, the patient is asked to protrude the tongue and should note any deviation of the tongue from the midline. The patient is instructed to move the tongue sideways. If any abnormalities are found, resistance is tested by applying pressure on the external surface of the cheek and asking the patient to push their tongue against the cheek.

Chairside Investigations

Toluidine blue (TB) staining

TB, tolonium chloride, which is a vital dye is believed to stain nucleic acids. It is used as an aid to the identification of clinically occult mucosal abnormalities and as a useful way of demarcating the extent of a potentially malignant lesion before excision of suspected lesion.[5]

Cytopathology

Smear

This is the method of collecting superficial epithelial cells by scraping the surface using tongue blade or spatula and then transferred on to the slide and fixed with the alcohol. Then, staining is done and examined under microscope for visualizing cell morphology and structure.

Brush biopsy

This is a method of collecting a transepithelial sample of cells from a mucosal lesion with the representation of the layers of the epithelium (superficial, intermediate, and parabasal/basal). A specially designed brush is used for epithelial cell collection and samples are eventually fixed onto a glass slide, stained with a modified Papanicolaou test, and analyzed microscopically through a computer-based imaging system. Results are reported as "positive" or "atypical" when cellular morphology is highly suspicious for epithelial dysplasia or carcinoma or when abnormal epithelial changes are of uncertain diagnostic significance, respectively. Results are defined as negative when no abnormalities can be found. The test is an intermediate diagnostic step where a scalpel biopsy must follow when an abnormal result is reported (atypical or positive).[6]

Incisional/excisional biopsy

This is the procedure of collection of samples from the lesion for cytopathological studies.

Chemiluminescence

This is a procedure where examination of oral mucosa is done with the help of chemiluminescent (blue/white) light which was recently implemented to improve the identification of mucosal abnormalities. Vizilite is the technology which involves the use of an oral rinse with a 1% acetic acid solution for 1 min followed by the examination of the oral mucosa under diffuse chemiluminescent blue/white light (wavelength of 490–510 nm). The theory behind this technique is that the acetic acid removes the glycoprotein barrier and slightly desiccates the oral mucosa and the abnormal cells of the mucosa then absorbing and reflecting the blue/white light in a different way with respect to normal cells. Hence, normal mucosa appears blue, whereas abnormal mucosal areas reflect the light (due to higher nuclear/cytoplasmic ratio of epithelial cells) and appear more acetowhite with brighter, sharper, and more distinct margins.[7]

Tissue fluorescence imaging

Tissue autofluorescence has been used in the screening and diagnosis of pre-cancer stages. Autofluorescence is a process

when the epithelial and stromal changes alter the distribution of tissue fluorophores and emit fluorescence after stimulation with intense blue excitation (400–460 nm) light. The autofluorescence signal is finally visualized directly by a human observer. With regard to the oral cavity, normal oral mucosa emits a pale green autofluorescence when viewed through the instrument handpiece while abnormal tissue exhibits decreased autofluorescence and appears darker with respect to the surrounding healthy tissue. Autofluorescence technology for inspection of the oral mucosa has been developed by LED Medical Diagnostics Inc. in partnership with the British Columbia Cancer Agency and is marketed as VELscope system.[8]

Several studies have investigated the effectiveness of the VELscope system as an adjunct to visual examination for (i) differentiating between benign and dysplastic/malignant changes and (ii) identifying dysplastic/malignant lesions (or lesion's margins) that are not visible to the naked eye under white light.[9]

Specialized Examination Procedures

Ultrasonography/pulsed (Doppler) ultrasound

Ultrasound is a technique using acoustic pressure wave, and the frequency of the wave is above the limit of human hearing which gets transmitted through tissues and produces biological effects.[10] This has been used for imaging purpose as it is non-invasive, reliable, and relatively simple technique. Recent advancements in this technique have given a 4th dimension in the form of color. Doppler to assess vascular changes. In addition, it is also being used to study tongue movements.[11]

Method - Ultrasound pulses are passed from a transducer positioned below the chin, through the skin and the muscular tissue of the tongue, and are reflected in proportion to changes in acoustic impedance, at transitions in tissue density in the tongue body, at the interface between the tongue dorsum and the ambient air, and at the oral cavity walls. It is used based on the frequency [Table 2].

It helps in studying the characteristics of arterial blood flow in the tongue, and usually abnormal pulse waves have been noted in the lingual arteries of individuals with evidence of compromised flow in other branches of the carotid arterial tree.[12]

Karen *et al*., 2003, assessed the tongue moments in feeding and speech through ultrasound and found that ultrasound has a potential to be a diagnostic tool in assessing the tongue movements, and furthermore, 3D reconstruction of tongue models can be done for documentation purpose.[13] Geddes *et al*., 2008, described the tongue movement and intraoral vacuum in 20 breastfeeding infants through ultrasound and stated that ultrasound imaging demonstrated that milk flow from the nipple into the infant's oral cavity coincided with both the lowering of the infants tongue and peak vacuum. And also, they said that recording tongue movements with ultrasound is noninvasive and has not been shown to have any biologic effects in humans at diagnostic intensities. This modality enables automated measurements of tongue movements and helps in assessing the diseases of the tongue of neuromuscular origin.[14]

Table 2: Applications of USG based on frequency

Applications in medicine	Frequency
Operative	Ranges between 2 and 8 KHz
Therapeutic	Ranges between 20 KHz and 3 MHz continuous or pulsed modes
Diagnostic	Ranges between 1.6 and 12 MHz

USG: Ultrasonography

Electromyography

Electromyography is a test to study the muscle functions. It is a non-invasive technique that measures the electrical activity of several muscles in the body to diagnose movement disorders and can also contribute to the assessment of prognosis in motor alterations. The use of surface electrodes has been introduced with considerable success.[15]

Cheng *et al.* done a study to assess the movement of the tongue during normal breathing in awake healthy patients using electromyography and suggested that the local movement of tongue varies between each individual. He found that, during inspiration, anterior movement of the genioglossus muscle can occur, and hence, he has stated that the tongue can act as a muscular hydrostat.[16]

Magnetic resonance imaging (MRI)

MRI was used as an alternative to imaging modalities involving radiation. It has been proven that it provides a greater details of soft-tissue structures, such as the tongue and oropharynx. MRI has the ability to provide multiple sections, which allows accurate delineation of the lingual musculature and the extent of tumor infiltration. The supine position of the patient is the major limitations of MRI as a research tool in the field of speech or deglutition because it causes difficulty in feeding and also MRI data acquisition is slow when compared with normal feeding and deglutition.[13]

Stone *et al.* stated that MRI imaging can explain normal as well as glossectomy movements of the tongue and there is a great need for understanding the biomechanical and muscular mechanisms of the tongue motion which provides data to help surgeons in planning and evaluating reconstructive surgery.

Computer-assisted tomography

These thin multiple axial sections are obtained using an X-ray source which rotates around the object and sensors are positioned on the opposite side of the circle from the X-ray source. Then, the data are reformatted with special software packages to produce multiplanar reformatted images and also images in all the three orthogonal planes (coronal, sagittal, and axial) which enable the accurate measurements for the evaluation.

It can be used to identify muscular atrophy which is caused due to hypoglossal nerve damage and large lesions, in cases

where the lesion is deep in the base of the tongue and cannot be detected by other approaches. This also be used for the detection of extension of head-and-neck carcinomas involving tongue and other parts.[17]

Murakami R *et al.*, in 1997, did a computed tomography (CT) and MR study of denervated tongue after radical neck dissection, found that the side of the tongue operated showed low density on CT scans, and concluded that, in patients who have undergone a neck dissection for a malignant process, abnormal imaging findings in the tongue not only might indicate a recurrence of tumor involving the hypoglossal nerve but also suggest the possibility of postoperative change and emphasize the importance of the denervated tongue in differentiating inflammatory from neoplastic diseases of the tongue.

Isotopic scanning techniques

The principle of this scanning is based on the visual image which shows the uptake of an isotope by abnormal tissue which often differs from healthy tissue and its distribution.

The images obtained are two dimensional which are similar to the appearance of contrast radiography. It can be used when a mass in the tongue is composed of specialized secretory tissue or other tissue, such as thyroid, which selectively concentrates intravenously administered radioactive 131I or 99Tc-pertechnetate. To outline the extent of oral tumors Gallium scanning, tumor labeling with radioactive indium and cobalt–bleomycin chelates are used. Bathi *et al.* reported a case where they have used 99mTc04 isotopic scanning to evaluate the type of tissue mass on dorsal surface of the tongue.[18]

Cineradiography

Cineradiography is a procedure of capturing radiographs of moving objects in rapid sequence so that the radiographs made are projected as motion pictures which helps us to understand the position and shape of the tongue in motion and also help us to diagnose abnormalities of swallowing, phonation, and other functions associated with congenital and surgically induced defects.[19]

A study was conducted on 20 post-polio syndrome patients using cineradiography to evaluate their swallowing defects, and author has found that the abnormalities were seen in the pharynx in varying degree in all. However, in one of the patients, they observed that dysphasia can occur as a late complication to poliomyelitis and concluded the cineradiography and flow radiography are useful technique to assess the severity of the disease and degree of decomposition.[20]

Scanning electron microscope (SEM)

The SEM uses a focused beam of high energy electrons to generate a variety of signals at the surface of solid specimens. SEM is a diagnostic tool used to study the surface topography of dorsum of tongue, the character and morphology of the different types of tongue papillae, and distribution and morphology of bacteria on the papillated areas of the dorsum. Many studies have been done on different animals, but in human still, it requires more studies to know the efficacy of SEM on the tongue. This can be of two types - video microscopy which is used for observation of the papillary surface of tongue and stereo microscopy which results a three-dimensional image. Both are used to study the tongue papillae, their capillary network, and taste pores.[10]

Conclusion

As diagnosis of tongue diseases plays an eminent role in the treatment of the disease, it has attracted an increasing amount of attention on various investigatory methods followed by examination such as shape, size, motion, and any disability which are very well recorded by advanced investigative techniques and also different microscopic techniques to study anatomy and other abnormalities can be very well appreciated. Such, updated techniques are very helpful in accurate diagnosis which leads to a good successful treatment.

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