



Review and Update: Advanced Investigation Methods for Diagnosis of Tongue Lesions

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ABSTRACT

Various specialized imaging modalities and guided microscopic methods developed in recent years, having proven value for the evaluation of tongue disorders. The list of which includes cineradiography, pulsed ultrasound, computer-assisted tomography, isotopic scanning, electromyography, magnetic resonance, video microscopy and stereo microscopy. The basic aim of the article is to review and throw light on the importance of complete examination of the tongue and application of advanced investigations for the proper diagnosis of the tongue lesions and its usefulness to the clinician.

Keywords: Tongue, Tongue lesions, Advanced investigation methods.

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INTRODUCTION

The belief that the general health of a person is reflected in his tongue from the days of Hippocrates.¹ The tongue is meant to be a trustworthy mirror of the health. It performs many functions like prehension and ingestion, suckling, swallowing, phonation and perception of sensations including taste characteristics, thermal changes, pain stimuli and general sensations and helps in jaw development. Traditionally the diagnosis of tongue lesions is always dedicated to the identification of syndromes rather than diseases. Cineradiographic studies help us to understand the position and shape of the tongue in motion. Pulsed (Doppler) ultrasound is used to measure tongue movements in speech and to study the characteristics of arterial blood flow in the tongue.² Computer-assisted tomography (CAT) is used to identify space occupying lesions and muscular atrophy secondary to hypoglossal nerve damage, in cases

where the lesion is deep in the base of the tongue and not detectable by other approaches. CAT scan can also be used for detection of extend of head and neck carcinomas involving tongue and other parts.³ Isotopic scanning techniques are used when the tongue is composed of specialized secretory tissue or other tissues, such as thyroid, which selectively concentrates intravenously administered radioactive ¹³¹I or ⁹⁹Tc-pertechnetate.⁴ Electromyography is a test to evaluate normal functions and also helps to detect the functional disorders of muscles of the tongue.⁵ Magnetic resonance imaging (MRI) is used as an alternative to imaging modalities for soft tissue structures, such as the tongue and oropharynx and also helps in assessment of speech sound.⁶ MRI has the ability to provide direct coronal or sagittal scanning sections. Scanning electron microscope (SEM) is a well-established tool for *in vitro* study of the surface topography of tongue dorsum, the character and morphology of the different types of tongue papillae and distribution and morphology of bacteria on the papillated areas of the dorsum.⁷ Video microscopy is useful for observation of the surface of tongue papillae. Stereo microscopy is similar to video microscopy and can be used to study the tongue papillae, their capillary network and taste pores.⁵

EXAMINATION OF TONGUE^{8,9}

Routine Examination

It includes inspection of dorsum of the tongue while it is at rest for any swelling, ulcers, coating or variation in size, color and texture.

- Careful observation of the distribution of filiform and fungiform papillae, margins of tongue, crenations and fasciculations, depapillated areas, fissures, ulcers and keratotic areas.

- Lingual frenal attachment and its deviations as the patient protrudes the tongue and attempts to move it to the right and left, should be observed.
- With a wrapped piece of gauze (4 × 4 cm) around the tip of the protruded tongue to steady it, and lightly press a warm mirror against the uvula to observe the base of the tongue and vallate papillae.
- The tongue should be gently guided to the right and left, to observe the entire lateral border of the tongue for ulcers, keratotic areas, red patches and the foliate papillae. This is to be repeated to the opposite side.
- Careful examination of the ventral surface of the tongue and floor of the mouth.
- The patient should touch the tip of the tongue to palate.
- The muscles of the tongue to be palpated gently for nodules and tumors, extending the finger onto the base of the tongue and pressing forward if this has been poorly visualized or if any ulcers or masses are suspected.

SPECIALIZED EXAMINATION PROCEDURES

Cineradiography

Cineradiography studies the oral cavity and pharynx during drinking, chewing, suckling, phonation and other activities helps us 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.

Brownly et al did a cineradiography in 20 postpolio syndrome patients to evaluate swallowing defects and found positive results and found that the abnormalities were seen in the pharynx in varying degree in all. But, in one of the patient they observed that dysphasia can occur as a late complication to poliomyelitis and cineradiography and flow radiography are useful technique to assess the severity of the disease and degree of decomposition.¹⁰ The visual inspection of speech articulation possible with high speed, X-ray motion-picture photography suggests the attempted fitting of pseudo speech continue to 'corresponding' speech articulation sequences, not only in the specific interest of improving the acoustic quality of simulated speech, with especial reference to timing phenomena, but also in the consequent general increase of knowledge about speech analysis, and as a contrivance for acoustically matching sustained articulation instants. Acoustically simulated 'steady-state isolated vowels' and corresponding slides of typical articulatory instants are presented as an introduction to a demonstration of high speed cineradiography of vowels uttered in isolation augmented with matching pseudo speech continue.²

Pulsed (Doppler) Ultrasound

Ultrasound is a form of mechanical acoustic pressure wave at frequencies above the limit of human hearing that when transmitted through biological tissues can produce different biological effects. Noninvasive ultrasound technique has recently been applied study laryngeal activity, pharyngeal wall displacement and tongue movements. Two types of echo ultrasound equipment can be used to monitor tongue movements in speech, A scan and sector scan. In the A scan 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. The most widely used applications in medicine are operative (usually has a frequency that ranges between 2-8 K Hz), therapeutic (usually has a frequency that ranges between 20 K Hz-3 M Hz either in continuous or pulsed modes), and diagnostic (usually has a frequency that ranges between 1.6-12 M Hz).³

It has been used to study the characteristics of arterial blood flow in the tongue, and 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. Karen M. Hiimae and Jeffrey B. Palmer in 2003 reviewed tongue moments in feeding and speech through ultrasound and stated that it is clear that new and very sophisticated ultrasound technology can generate the data to produce 3D models of the tongue surface.⁴

Donna T Geddes et al in 2008 described the tongue movement and intraoral vacuum in 20 breastfeeding infants through ultrasound and concluded 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. Therefore vacuum is likely to play a major role in milk removal from the breast.¹¹

Recording tongue movements with ultrasound is noninvasive and has not been shown to have any biologic effects in humans at diagnostic intensities. As a result it is possible to record a substantial number of samples, each the duration of a typical utterance. Also, pulsed ultrasounds particularly enable to on-line computerized measurements and analysis techniques.¹²

Computer-Assisted Tomography

The CT system was invented in 1972 by Godfrey Newbold Hounsfield of EMI Central Research Laboratories. In this X-ray slice data is generated using an X-ray source that

rotates around the object, X-ray sensors are positioned on the opposite side of the circle from the X-ray source. Many data scans are progressively taken as the object is gradually passed through the gantry. They are combined together by the mathematical procedure known as tomographic reconstruction. It can be used to identify space occupying lesions and muscular atrophy secondary to hypoglossal nerve damage, in cases where the lesion is deep in the base of the tongue and not detectable by other approaches. CAT scan can also be used for detection of extend of head and neck carcinomas involving tongue and other parts.¹³ Ryuji Murakami et al in 1997 did a CT and MR study of denervated tongue after radical neck dissection and found that the side of the tongue operated on 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.¹⁴

Isotopic Scanning Techniques

The principle of obtaining diagnostic information from a visual image of isotope distribution is based on the fact that the uptake of an isotope by abnormal tissue often differs from that by normal, healthy tissue. Sometimes it is more, in some other cases less. Present techniques offer a two-dimensional image, somewhat similar to the appearance of X-ray absorption as seen on an X-ray picture. 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. Gallium ⁶⁷Ga scanning and tumor labeling with radioactive indium and cobalt-bleomycin chelates also have been used to outline the extent of lingual and other oral tumors with varying success.⁴ Bathi, Taneja and Rao reported a case of asymptomatic tissue growth on dorsal surface of the tongue, isotopic scanning with ^{99m}TcO₄ was done to evaluate the type of tissue mass.¹⁴

Electromyography

Electromyography is a test to study the muscle functions. It has been used for many years to study the action potentials in actively contracting muscles and has contributed to an understanding of lingual and masticator muscular function and also in detecting uncoordinated muscular movements

in diseases like dyskinesia, dystonia, and various neuromuscular disorders. It is a noninvasive technique. Use of surface electrodes (in earlier techniques thin-needle electrode inserted in the muscle to the studied) have been introduced with considerable success.² According to Cheng et al movement of the tongue during normal breathing in awake healthy humans with electromyography and suggested that the patterns of local movement vary between subjects. There is anterior movement of the genioglossus muscle at the level of the epiglottis during inspiration with limited movement in nearby tissue including the geniohyoid, and hence even during respiration tongue behaves as a muscular hydrostat.¹⁵

Mohammad Hajiha et al contributed to the field of physiology by being the first to report a suppression of respiratory muscle activity caused by the presence of opioids at a distinct central nervous system motor pool, and the first characterization of the receptor mechanisms underlying this suppression.¹⁶

Magnetic Resonance Imaging

MRI used as an alternative to imaging modalities involving radiation. It has proven to be vastly superior in the detail it provides, of soft-tissue structures, such as the tongue and oropharynx.⁵ MRI has the ability to provide, direct coronal or sagittal scanning sections, which allows accurate delineation of the lingual musculature and the extent of tumor infiltration. MRI has serious limitations as a research tool for studies of speech or deglutition because of supine position of the patient which causes difficulty in feeding and also MRI data acquisition is slow when compared with normal feeding and deglutition.⁴ According to Mauren Stone et al MRI imaging can explain normal as well as glossectomy movements of the tongue.⁶ There is a need for a greater understanding of the biomechanical and muscular mechanisms that underlie compensatory tongue motion in order to provide outcome data that can assist surgeons in planning and evaluating reconstructive surgery.

Scanning Electron Microscope

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 well-established tool for *in vitro* study of the surface topography of tongue dorsum, the character and morphology of the different types of tongue papillae and distribution and morphology of bacteria on the papillated areas of the dorsum.⁶ Many studies have been performed in different animals but in human more studies are required to know the efficacy of SEM on tongue.

Table 1: Advanced investigation methods and its applications in tongue disorders

S. no.	Name of advanced investigation method	Applications in tongue disorders
1.	Cineradiography	Position and shape
2.	Pulsed ultrasound	Arterial blood flow
3.	Computer-assisted tomography	Location of the lesion, nerve damage
4.	Isotopic scanning	Abnormal tissue detection
5.	Electromyography	Muscle function
6.	Magnetic resonance imaging	Muscle function
7.	Scanning electron microscopy	Surface topography dorsum of tongue
8.	Video microscopy	Surface and structure of lingual papillae
9.	Stereo microscopy	Tongue papillae, capillary network, taste pores

Video Microscopy

Video microscopy is useful for observation of the surface of tongue papillae. Negoro et al in 2004 conducted a study in 10 individuals for observation of tongue papillae by video microscopy and contact endoscopy to investigate their correlation with taste function and concluded that in the normal taste group, round-shaped papillae and clear blood vessels were observed with both microscopy and contact endoscopy.⁵ In the taste disorder group, flat and irregular papillae were observed with microscopy. Blood vessel flow of the papillae was observed to be poor with contact endoscopy. It can be used *in vivo* for visualization of tongue papillae, their capillary network, and taste pores.

Stereo Microscopy

A stereo microscope is an optical microscope fitted with two sets of lenses, each positioned to view an object from a slightly different angle. The result is a three-dimensional image. In order to produce a clear, functional three-dimensional image, a stereo microscope relies on reflected, exterior light sources to illuminate its subject, instead of the brighter plate lights that shine through the specimen on a standard microscopy. It is similar to video microscopy and can be used to study the tongue papillae, their capillary network, and taste pores.

CONCLUSION

As tongue diagnosis has played a prominent role in the subsequent treatment of disease, it has attracted an increasing amount of attention as various investigatory methods have been used to detect tongue abnormalities. Shape, size, motion and any disability are very well recorded by investigative techniques like cineradiography, MRI, ultrasonography, CAT, isotopic scanning techniques, electromyography and also different microscopic techniques to study anatomy and any type of abnormality in papillary surface can be very well appreciated. Such, modernized

techniques are very helpful in accurate diagnosis which leads to proper treatment.

To summarize, all the advanced investigation methods and its applications in tongue disorders have been mentioned in Table 1.

CLINICAL SIGNIFICANCE

The tongue is meant to be a trustworthy mirror of the health and it is believed that the general health of a person is reflected in his tongue. It has attracted an increased amount of attention these days due to the various diseases involving the tongue. The advanced investigation methods are extremely helpful for the proper diagnosis of these diseases. It also plays an important role in evaluating many muscular disorders associated with improper functioning of the tongue. They are very useful to the dental clinician in diagnosing unpredictable involvement and leads to the appropriate management of such diseases.

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