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Magnetic Resonance Imaging in Tongue Malignancy

Dr. Hiral Hapani M.D. Radiology[1], Dr. Jagruti Kalola M.D. Radiology[2],
Dr. Jay Hapani D.N.B. Radiology[3], Dr. Anjana Trivedi M. D. Radiology
[1](Assistant Professor, dept. of Radiology, P.D.U. Medical college, Saurashtra university, Rajkot, Gujarat, India)
[2](AssociateProfessor, dept. of Radiology, P.D.U. Medical college, Saurashtra university, Rajkot, Gujarat, India)
[3](Consultant Radiologist, Milestone Hospital, Rajkot, Gujarat, India)
[4](Professor and Head of dept., dept. of Radiology, P.D.U. Medical college, Saurashtra university, Rajkot, Gujarat, India)

Abstract: *Accurately determining pre-therapeutic staging is an important factor in the treatment planning and prognosis in squamous cell carcinoma of tongue. While clinical examination allows direct visualization, it cannot evaluate deeper extension of disease. Cross-sectional imaging has become the cornerstone in the pretreatment evaluation of these cancers and provides accurate information about the extent and depth of disease that can help decide the appropriate management strategy and indicate prognosis. Magnetic resonance imaging (MRI) can produce excellent-quality images and direct multiplanar formats without ionizing radiation.Early cancers can be treated with either surgery or radiotherapy while advanced cancers are offered a combination of surgery, radiotherapy and chemotherapy. Imaging can decide resectability, help plan the precise extent of resection, and indicate whether organ conservation therapy should be offered. Quality of life issues necessitate preservation of form and function and pretreatment imaging helps plan appropriate reconstruction and counsel patients regarding lifestyle changes. This review aims to familiarize the radiologist with the relevant anatomy of the tongue, discuss the specific issues that influence prognosis and management at the above subsite, the optimal imaging methods, the role of imaging in accurately staging these cancers and in influencing management.*

Keywords: *Computed tomography, Magnetic resonance imaging, TNM staging, tongue carcinoma*

I. Introduction

The tongue is the centre piece of the oral cavity and the oro pharynx. It enables taste of food and plays a critical role in formation of food bolus and deglutition. The tongue is also crucial for speech. Speech is impaired by glossectomy, the degree of which depends on the extent of the resection. In fact, the earliest sign of tongue paresis is a change in the quality of speech.

Given the importance of the tongue, tongue carcinoma should be accurately staged in order to optimize treatment options and preserve organ function. The intent of this review is to familiarize radiologists with the pertinent anatomy of the tongue and the behavior of tongue carcinoma so as to map malignant infiltration accurately.

Squamous cell carcinoma of the tongue spans two regions. The anterior two thirds (oral tongue) is a common subtype of squamous cell carcinoma of the oral cavity where as the posterior third (base of tongue) is considered part of the oropharynx.

II. Materials And Methods

This retrograde study consisting of 30 patients was conducted in the department of Radio diagnosis , P.D.U. Medical College and Civil Hospital, Rajkot. MRI was performed with GE 1.5 T 8 channeled machine. Sequences used were – T1 axial and coronal, T2 W axial ; STIR axial and coronal; contrast enhanced study was performed whenever necessary.

Table I: MRI Tongue protocol

Sequence	Slice	Sl thick	Gap	Matrix	Notes
T1 axial	29	4mm	0.4mm	512	
T1 coronal	23	4mm	0.4mm	512	
STIR coronal	23	4mm	0.4mm	256	Wide FOV, Interpolation on
T2 Fatsat axial	29	4mm	0.4mm	512	
T1 fatsat axial +Gd	23	4mm	0.4mm	512	
T1 fatsat coronal +Gd	19	4mm	0.4mm	512	
T1fatsat Sagittal + Gd	19	4mm	0.4mm	512	If required (tongue base, skull base)

III. Discussion

Applied Anatomy:

The tongue has a dorsum, apex, inferior surface and root. The root (base) is attached to the hyoid bone and mandible while the apex forms the tip of the tongue. The sulcus terminalis, a shallow groove with the circumvallate papillae just anterior to it, divides the tongue into the oral (anterior two-thirds) and pharyngeal (posterior third) parts. As a general guide on axial imaging, a line joining the anterior aspect of the mandibular rami may be used as the dividing line between these two parts, which differ in their developmental origins and hence their nerve supplies.

The mucosa of the oral tongue derives from the ectodermal lining of the midline tuberculum impar and the pair of lateral lingual swellings of the first pharyngeal (mandibular) arch. The sensory supply of this mucous membrane, excluding the region of the circumvallate papillae is by the lingual branch of the mandibular nerve whose trigeminal component mediates common sensation, and whose chorda tympani component mediates taste. The mucosa of the pharyngeal tongue (base of the tongue) originates from the endodermal lining of the third pharyngeal arch, with a small contribution from the fourth arch. This mucosa, together with the pre-sulcal area of the circumvallate papillae is predominantly supplied by the glosso pharyngeal nerve, which mediates both common sensation and taste. The small area of lingual mucosa in the anterior wall of the vallecula, which develops from the fourth pharyngeal arch, is mediated by the internal laryngeal nerve.

The oral tongue has a free margin bounded anteriorly and laterally by the alveolar margins. The pharyngeal tongue, which is really the anterior wall of the oropharynx, extends from the sulcus terminalis to the epiglottis and is bounded laterally by the glossopharyngeal sulci. The valleculae (which are considered as part of the tongue), are 1-cm strips of smooth mucosa that form the transition between the tongue base and the epiglottis.The tongue has a supporting fibrous framework consisting of the lingual septum and the hyoglossus membrane. The midline fibrous lingual septum divides the tongue into two symmetrical muscular halves.

The tongue is essentially a mass of skeletal muscles covered by mucous membrane. Its muscles are divided into intrinsic and extrinsic groups. The intrinsic muscles are entirely within the tongue with no bony attachment, and are organized into superior and inferior longitudinal, vertical and transverse bands. Their principle function is altering the shape of the tongue. The extrinsic muscles consist of genioglossus, hyoglossus, styloglossus and palatoglossus. These extrinsic muscles stabilize the tongue and alter its position, as well as its shape.The anatomy of the tongue is well demonstrated on magnetic resonance imaging (MRI). On axial T1-weighted images, fat with high signal intensity can be seen interspersed between the muscles of intermediate signal intensity.

Genioglossus is the largest of all the tongue muscles and forms the bulk of the tongue. It arises from the genial tubercle and is easily seen on computed tomography (CT) and MRI. It fans out widely and inserts inferiorly into the hyoid bone; posteriorly into the tongue base; and superiorly into the entire ventral surface of the tongue. Hyoglossus is a thin quadrilateral sheet of muscle arising from the hyoid bone. It ascends superiorly, interdigitating with the fibres of the styloglossus, and attaches to the side of the tongue. The hyoglossus muscles define the lateral margins of the tongue and are readily identified on CT and MRI. Both the styloglossus (which arises from the styloid process and stylohyoid ligament) and the palatoglossus (which originates from the palatine aponeurosis) cannot be seen with certainty on imaging studies.

Tongue muscles are derived from the myotomes of the occipital somites, which migrate anteriorly carrying their nerve supply. All the muscles of the tongue, intrinsic and extrinsic, are thus innervated by the hypoglossal nerve. The exception being palatoglossus, which being essentially a palate muscle, is supplied by the pharyngeal plexus.

The lingual artery, a branch of the external carotid artery, supplies the bulk of each half of the tongue. There are small contributions from the tonsillar branch of the facial artery and from the ascending pharyngeal artery. The fibrofatty lingual septum restricts any significant vascular anastomosis across the midline except the tip of the tongue. One lingual artery may be sacrificed, but sacrificing both arteries leads to high risk of anterior tongue necrosis and almost certain loss of the tongue base [1].

The tongue has a rich lymphatic network. Unlike the vascular supply that remains largely unilateral, lymph from one side, particularly from the tongue base, drains into nodes on both sides of the neck. Lymph from the tip of the tongue may drain to the sub mental nodes. Marginal lymphatics from the outer third of the rest of the oral tongue are directed to ipsilateral submandibular and jugulodigastric nodes. Central lymphatics of the inner two-thirds of the oral tongue have pathways to nodes of both sides of the neck. As a clinical guide, tumour extending more than 5 mm from lateral tongue margin has an increased risk of bilateral metastatic lymphadenopathy [2]

Accurate tumour staging is crucial in cancer management because it (i) aids treatment planning; (ii) gives some indication of prognosis; (iii) assists the evaluation of treatment outcomes; (iv) facilitates the exchange of information between treatment centres; and (v) contributes to the continuing research and study of human cancer.

TNM staging:

At present, the Tumour Node Metastasis (TNM) classification is the most commonly used system for describing malignant tumours, their regional involvement and distant metastases [3]. The TNM and stage grouping are presented below. This TNM staging system should be the guide for every radiologist when reporting studies performed for assessment of tongue carcinomas.

TNM classification of carcinomas of the oral cavity

T — Primary tumour

TNM	FIGO
TX	Primary tumour cannot be assessed
T0	No evidence of primary tumour
Tis	Carcinoma in situ
T1	Tumour 2 cm or less in greatest dimension
T2	Tumour more than 2 cm but not more than 4 cm in greatest dimension
T3	Tumour more than 4 cm in greatest dimension
T4a (lip)	Tumour invades through cortical bone, inferior alveolar nerve, floor of mouth, or skin (chin or nose)
T4a (oral cavity)	Tumour invades through cortical bone, into deep/extrinsic muscle of tongue (genioglossus, hyoglossus, palatoglossus, and styloglossus), maxillary sinus, or skin of face
T4b (lip and oral cavity)	Tumour invades masticator space, pterygoid plates, or skull base; or encases internal carotid artery

Note: Superficial erosion alone of bone/tooth socket by gingival primary is not sufficient to classify a tumour as T4.

N - Regional Lymph Nodes

NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis in a single ipsilateral lymph node, 3 cm or less in greatest dimension
N2	Metastasis as specified in N2a, 2b, 2c below
N2a	Metastasis in a single ipsilateral lymph node, more than 3 cm but not more than 6 cm in greatest dimension
N2b	Metastasis in multiple ipsilateral lymph nodes, none more than 6 cm in greatest dimension
N2c	Metastasis in bilateral or contralateral lymph nodes, none more than 6 cm in greatest dimension
N3	Metastasis in a lymph node more than 6 cm in greatest dimension

Note: Midline nodes are considered ipsilateral nodes.

M – Distant metastasis

MX	Distant metastasis cannot be assessed
M0	No distant metastasis
M1	Distant metastasis

Stage grouping

Stage 0	Tis	N0	M0
Stage I	T1	N0	M0
Stage II	T2	N0	M0
Stage III	T3	N0	M0
	T1,T2,T3	N1	M0
Stage IVa	T4a	N0,N1	M0
	T1,T2,T3,T4a	N2	M0
Stage IVb	T4b	Any N	M0
	Any T	N3	M0
Stage IVc	Any T	Any N	M1

Imaging:

A common staging system is used for all squamous cell carcinomas of the oral cavity, with tumour staging being based on size and extension into adjacent structures. Nodal staging is the same as that used for SCCs of the oral cavity, oropharynx, hypopharynx and larynx.

Whether CT or MRI is used the same features should be assessed:

- size of tumour and tumour thickness
- extension across the midline
- extension beyond the intrinsic muscles of the tongue
- involvement of adjacent structures
  - neurovascular bundle and submandibular duct in the floor of mouth
  - mandible

MRI is the preferred modality in the evaluation of tongue carcinomas .The abnormal signals seen on MRI are well correlated with pathological findings [4]. Tumour invasion of the floor of the mouth is particularly well seen on coronal images. Sagittal images provide information on tongue base involvement and the extent of pharyngeal infiltration that cannot be seen on CT. However, cortical bone involvement, notably the mandible is diagnosed with a higher level of certainly on CT.

Oral tongue carcinoma:

Nearly all tumours of the oral tongue occur on the lateral and under surface. Dorsal tumours are uncommon but when they do occur, they are usually located near the midline and more posteriorly. Oral tongue tumours tend to remain in the tongue. Tumours in the anterior third of the oral tongue invade the floor of the mouth . Middle-third lesions infiltrate the musculature of the tongue and later, the lateral floor of the mouth . Carcinomas involving the posterior third of the oral tongue grow into the musculature of the tongue, the floor of the mouth, the anterior tonsillar pillar, the tongue base, the glosso tonsillar sulcus and the mandible .

MRI provides valuable information both within and without the tongue. The tongue carcinoma may extend far beyond the gross tumour margin seen on surgery, which is often deceiving. It is known that the most important factor governing local recurrence is the resection margin [5]. Whereas 1 cm is generally considered adequate for most squamous cell carcinomas, the margins for tongue cancer should be 1.5–2 cm. Tumours with deep margins are often difficult to assess during surgery. In addition, these tumours are technically more difficult to resect. Hence, deep margins are frequently the site of positive or inadequate resection margins. Up to 35% of patients have nodal metastasis on presentation . Five percent of these patients have bilateral lymph node involvement. The first echelon nodes are the submandibular and jugulodigastric nodes. Submental node involvement is uncommon except in patients with tumour at the tip of tongue. It should be noted that in patients with clinically N0 neck, the overall occult metastatic rate is approximately 30%. Various clinical studies have been performed to correlate the depth of tumour invasion with the likelihood of cervical nodal metastasis [6–8]. These studies reveal that the single most important factor in predicting lymph node metastasis is the depth of tumour invasion.

Tongue base carcinoma

This is a clinically silent region and tumours tend to spread with deep infiltration. As a general rule, the extent of these tumours is underestimated during clinical examination. Tongue base tumours tend to remain in the tongue except for laterally placed lesions or late cases [1]. Under such circumstances, tongue base tumours may extend into the tonsillar fossa. Tonsillar carcinomas, on the other hand, have a tendency to invade the tongue base. For tongue base carcinoma, the first echelon nodes are the jugulodigastric nodes , followed by mid and lower jugular nodes. Retropharyngeal nodes are occasionally involved. Submandibular nodes may be involved if there is anterior tumour extension. Submental nodes are rarely involved. Seventy-five percent of patients have positive nodes on presentation while 30% have bilateral nodal metastases . Patients with clinically N0 neck have a 30%–50% rate of occult metastases.

Treatment

In general, radiation therapy and surgery have similar results for similar stages. Total glossectomy is associated with severe speech and deglutition dysfunction. It is poorly tolerated and the procedure is thus rarely performed [1, 2]. Hemiglossectomy preserves some speech and swallowing ability. The option between surgery and radiation therapy also depends on the practice and preference of a particular head and neck oncology service.Radiation therapy is often used as the first modality while surgery is reserved for recurrence. Surgical salvage is good for small lesions but the effectiveness drops with progressively larger lesions. Hence, partial glossectomy followed by radiation therapy is the method of choice in many centres. In view of the high incidence of occult metastases in clinically N0 neck, several studies have recommended elective neck dissection in this group of patients. Investigations have demonstrated the prognostic value of tumour volume measured on

CT and tumour thickness (determined on ultrasound or MRI) in predicting occult metastases [9]. These studies suggest that tumours with thickness exceeding 4–6 mm or a tumour volume exceeding 13 ml have significant risk of occult metastases. Recently, segmentation techniques were introduced to measure carcinoma tumour volume on MR images [10].

IV. Conclusion

In conclusion, MRI is the imaging modality of choice for evaluation of tongue carcinomas. Coupled with an in-depth understanding of the anatomy of the tongue and behavior of the tongue carcinoma, this will allow accurate staging of the tumour, which in turn is crucial in optimising the treatment options.

Illustrations:

Figure 1: normal anatomy

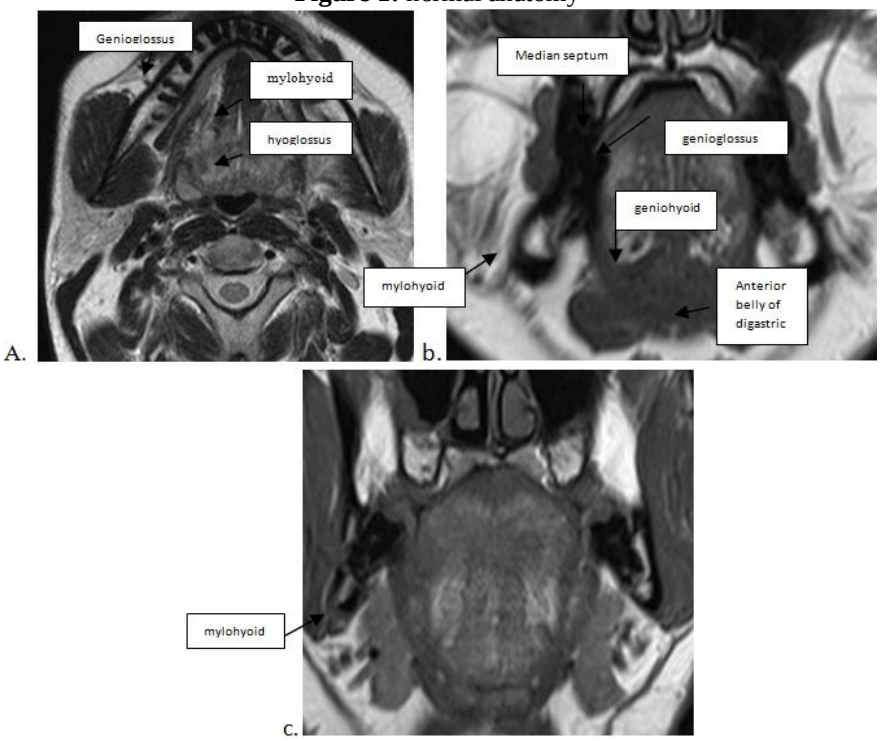
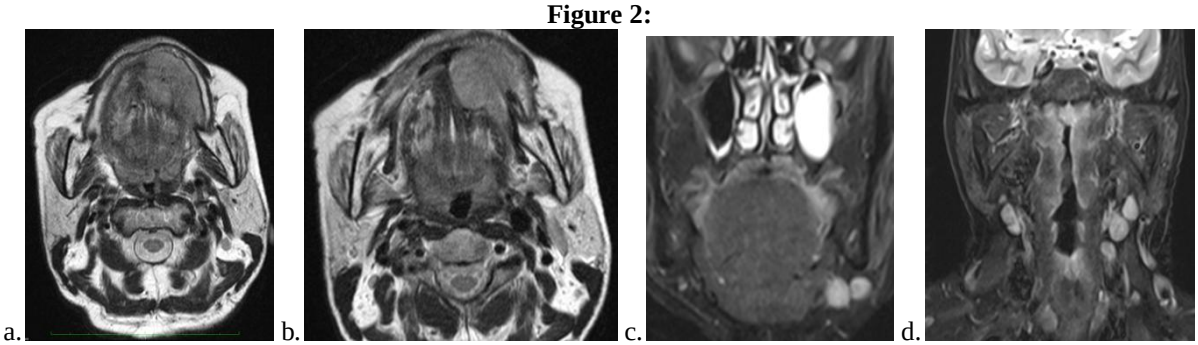
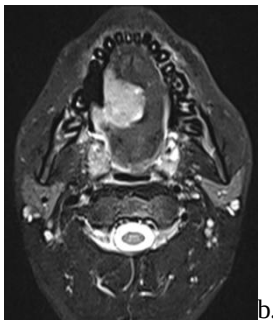
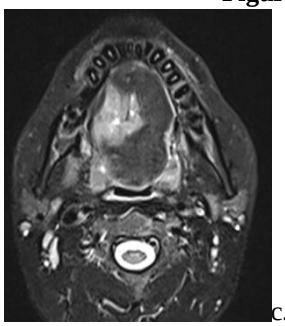
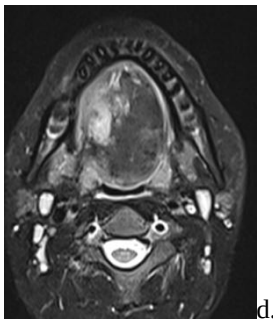
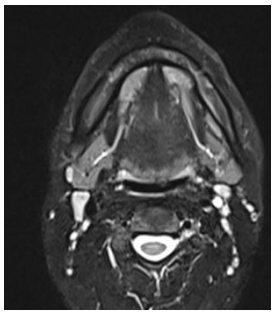


Figure 2:



a,b : T2W axial images showing hyperintense mass lesion arising from the left lateral and anterior aspect of the tongue extending upto lingual septum and crossing the mid line with encasement of the left lingular artery anteriorly. c,d: STIR Coronal images showing lymph nodes in level Ib , II and III.

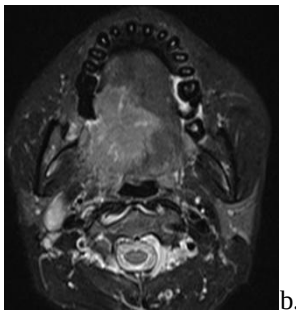
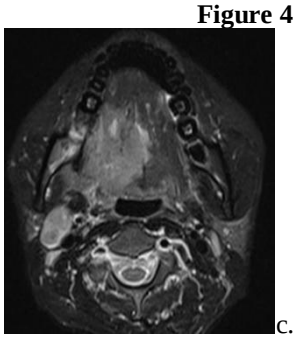
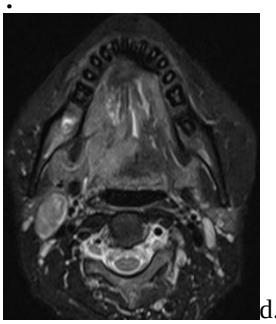
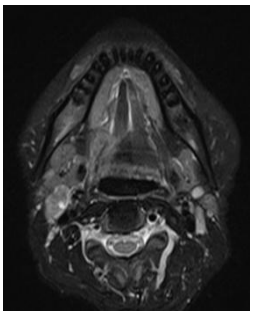
Figure 3:

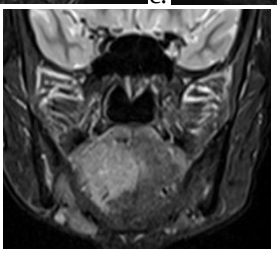
a.  b.  c.  d. 

e. 

a,b,c,d – T2FS axial and e – STIR Coronal images showing well defined heterogenous signal intensity nodular mass lesion involving right lateral aspect of the tongue and extending upto lingual septum and crossing mid line.It involves intrinsic muscles of tongue including genioglossus,myelohyoid and geniohyoid.Inferiorly, the lesion invades the lateral floor of mouth..Heterogenous signal seen in the body of right mandible –possible invasion.

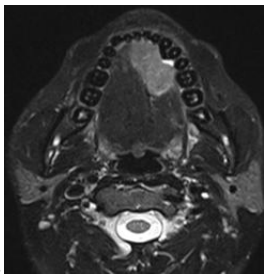
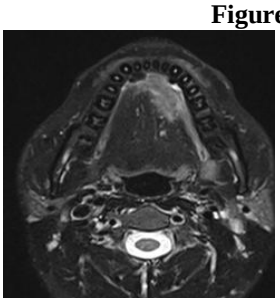
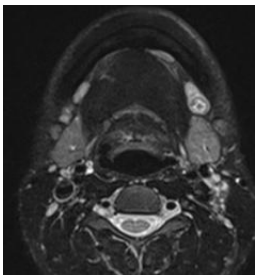
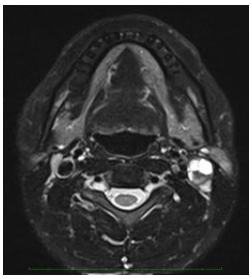
Figure 4 :

a.  b.  c.  d. 

e. 

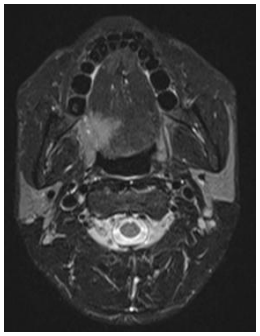
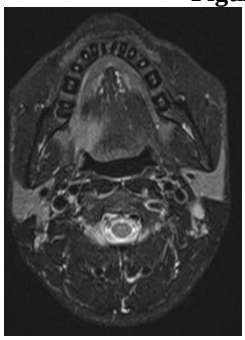
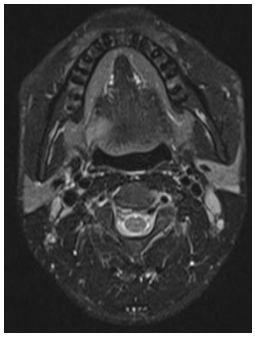
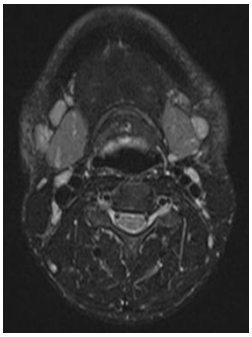
a,b,c,d :T2FS axial images e : STIR CORONAL showing well defined heterogeneous signal intensity nodular mass lesion involving right lateral and anterolateral aspect of the tongue which is extending upto lingual septum and crossing the mid line.It involves intrinsic muscles of the tongue including genioglossus, myelohyoid and geniohyoid. Right sublingual artery encased by the lesion s/o invasion. Posteriorly, the lesion reaches upto base of tongue with invasion of vallecula on right side. The lesion abuts the anterior tonsillar pillar on right side. Heterogenous marrow signal noted in posterior body and ramus of right mandible s/o invasion. Multiple lymph nodes seen at level Ib,II bilaterally.

Figure 5:

a.  b.  c.  d. 

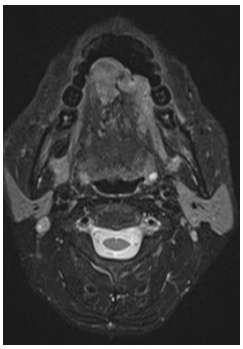
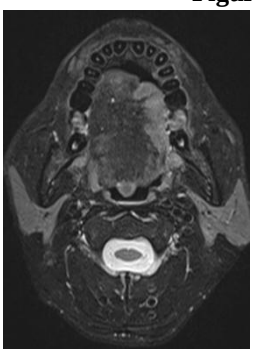
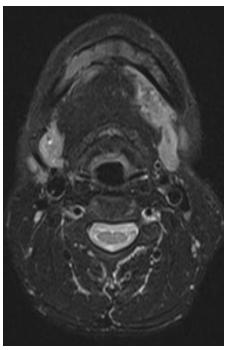
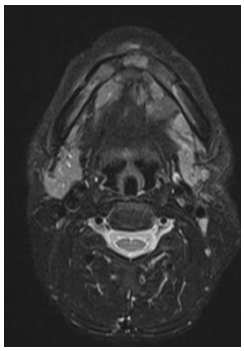
T2FS axial images reveal well defined heterogenous signal intensity nodular mass lesion involving the anterior tongue on left side.It crosses midline anteriorly and involves genioglossus and geniohyoid.Enlarged lymph nodes in level Ib and II on left side.

Figure 6 :

a.  b.  c.  d. 

T2FS axial images show well defined hyperintense mass lesion involving right lateral aspect of tongue not extending upto midline. It involves intrinsic muscles of the tongue including genioglossus and geniohyoid. Posteriorly, it invades right palatoglossal fold and anterior tonsillar pillar. Multiple lymph nodes bilateral level I

Figure 7:

a.  b.  c.  d. 

T2FS axial image: Well defined hyperintense nodular mass lesion involving anterior and lateral tongue on left side extending upto lingual septum and crossing midline to involve right anterior tongue. It involves intrinsic muscles of the tongue including genioglossus, myelohyoid and geniohyoid. Inferiorly, involvement of antero-lateral aspect of left submandibular gland. Patchy, heterogenous signal in body of mandibles bilaterally on anterior aspect suggest marrow infiltration.

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