International Journal of Otorhinolaryngology and Head and Neck Surgery
Munjal M et al. Int J Otorhinolaryngol Head Neck Surg. 2023 Sep;9(9):772-776
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20232533

Review Article

Imaging in head and neck cancers: a review

Manish Munjal[1], Shubham Munjal[1]*, Vanshika Saggar[2], Hardeep Kaur[1], Vineeta Arora[3], Lovleen Sandhu[1], Iti Bharadwaj[1], Anurima Arora[1], Devambika Mehta[1], Anjana Pillai[2]

[1]Department of ENTHNS, Dayanand Medical College Ludhiana, Punjab, India
[2]Department of Dental Surgery, BJS Dental College Ludhiana, Punjab, India
[3]Guru Teg Bahadur Hospital Ludhiana, Punjab, India

Received: 31 May 2023
Accepted: 03 August 2023

***Correspondence:**
Dr. Shubham Munjal,
E-mail: manishmunjaldr@yahoo.com

ABSTRACT

Imaging plays a vital role in the diagnosis, therapeutics-surgical or radiotherapy and prognostication of malignancies of the head and neck region. Imaging may range from simple plain radiography of the neck and the sinuses depicting mouse nibbled features of bone erosion and encroachment of air shadows, to functional imaging that analyses the metabolic status of the cancerous bed. Contrast enhancement further can delineate the vascularity of the lesion. Different imaging modalities are employed to study the various sites and sub-sites of the face and the neck to pick up the extent of infiltration into the tissues in their vicinity.

Keywords: Head-neck, Neoplasia, USG, CT scan, MRI, PET

INTRODUCTION

Globally, head and neck malignancies are predominant India by itself has 20% of these unfortunate individuals.[1,2] These tumors directly involve the vital organs of speech production, respiration, phonation, swallowing, taste, smell and hearing. Thereby these malignancies are associated with marked morbidity.[3] The locally advanced tumors contribute to significant mortality and are a major public health issue. Squamous cell carcinoma is the most common malignancy (95%) encountered, among the varied range of neoplasia of the head and the neck followed by salivary gland tumors, lymphomas, sarcomas, and thyroid lesions.[3,4] The stage of presentation is a crucial factor affecting the prognosis of head and neck squamous cell carcinoma. Aggressive intervention is required in advanced staged diseases including radical surgeries and post operative adjuvant chemotherapy with or without radiation, with likelihood of significant morbidity. A favorable prognosis of head and neck cancer malignancy necessitates an early diagnosis.

REVIEW OF LITERATURE

Radiological study plays an integral role in the diagnosis, staging and management approach for head and neck cancers. The advent of advanced 3-D cross-sectional imaging modalities has brought a revolution in diagnosis and management of HNSCC.[4] Imaging supplements pathological findings and endoscopic interventions. It is a crucial screening tool for diagnosis, staging of extent of the cancer spread (in accordance with TNM staging) and facilitates planning of management strategy.[4]

RADIOLOGICAL MODALITIES

The usual sites involved in metastasis of head and neck neoplasias are lymph nodes of the neck and the peripheral nerves. Head and neck malignancy has a poor prognosis if the individual presents with metastatic cervical lymphadenopathy. Thus, for staging of cancer and planning the therapeutic modalities, detection of cervical lymph node metastasis is vital.[5]

Ultrasonography (USG) and computed tomography (CT) are the basic imaging studies. MRI (magnetic resonance imaging), PET (positron emission tomography) and SPECT (single photon emission computed tomography) are next in the hierarchy. CT perfusion, CE-USG (Contrast Enhanced ultrasonography) and DWI-MRI are the recent advancements in imaging modalities.[5]

Precise staging of head and neck malignancies, prognostication, and selection of appropriate therapeutic intervention necessitate imaging modalities.[6,7] The primary site of cancer dictates which imaging modality is to be resorted to in oral cavity. Especially at sites namely- anterior tongue, retromolar trigone, and floor of mouth, MRI (Magnetic Resonance Imaging) is the preferred diagnostic tool. It is even useful for assessment of small primary tongue lesions and their sub mucosal extent.[6,7]

When tumor invasion is suspected, MRI is crucial in evaluation of adjacent mandible, soft tissues and other osseous structures as it provides superior soft tissue contrast and can even catch early, changes in bone marrow.[6-8]

In the oro pharynx, MRI is the preferred imaging tool. MRI with STIR sequences identifies small or subclinical primaries in the base of the tongue as well as the tonsil that usually manifests with cervical lymphadenopathy.[8] Misleading artifacts due to breathing and swallowing movements are usually noted in MRI studies of the oral cavity and the oro pharynx.[8]

MRI is the ideal imaging modality for nasopharyngeal carcinomas, orbital in and intracranial extensions, peri neural tumors and bone marrow involvement.[6,7] In evaluation of osseous destruction CT scan is a better imaging modality.[6,7]

MRI imaging of larynx is affected by artifacts in individuals who have impairment in swallowing, aspiration or breathing in the supine position as it is a long duration procedure. Therefore, it is a suboptimal technique of evaluation of tumors of the larynx.[6-8] CT is the preferred modality in primary laryngeal or hypo pharyngeal malignancy, including adjacent cartilaginous, bony, and soft tissue structures.[6,7] MRI with contrast is ideal for detection of involvement of the laryngeal cartilages.

In the advanced stage, nasopharyngeal tumors commonly present as palpable nodal neck disease. Accurate classification of primary site and the cervical nodal involvement, can be undertaken with the MRI.[8]

Though PET, CT, MRI are the best diagnostic imaging modalities for nasopharyngeal malignancy but tumor invasion into adjacent soft tissues i.e., the pharyngobasilar fascia, sinus of Morgagni, skull base, intracranial and perineural tissues is primarily evaluated on MRI.

In sino- nasal malignancy -CT, MRI, and PET/ CT are beneficial.[7]

In paranasal inflammatory diseases, CT is the diagnostic modality of choice because of sharp delineation of bone. However, in suspected cases of cephalocele, CT can be complemented with MRI.[9]

COMPUTED TOMOGRAPHY (CT SCAN)

Computed tomography has been available for over a few decades. Since the year 1981, particularly lymph nodes in the neck are assessed by this modality. The "consistent" detection of lymph node harboring pathology was attributed to this non invasive imaging modality.[10]

Cervical lymph node metastasis in confirmed head and neck lesions can be predicted utilizing protocols and criteria suggested by different centers. Though not followed by all, central necrosis in the lymph node are quite a reliable indicator of metastasis and the most specific sign of metastatic lymphadenopathy. Another criterion for malignancy is the irregular enhancement and group formation of nodes.[11]

On contrast enhanced CT, the parameters for cervical lymph node metastasis are as:[11] 1) Size: Axial diameter> 10mm (Short axial diameter) 2) Shape: longitudinal length/ trans-axial width ratio < 2. 3) Grouping: Group of 3 or more modes of 8-10 mm in the same drainage area of tumor.

CENTRAL NODAL NECROSIS

There is water depletion in the central area with an irregular enhancement. Necrosis in lymph nodes, is best studied on contrast enhanced computed tomography.

The 2004 King et al retrospective study documented metastatic cervical lymph node necrosis with a sensitivity of 91%, specificity of 93%, and positive predictive value of 91% and negative predictive value of 93%.[11]

EXTRA CAPSULAR SPREAD

Infiltration around and the eradication of the adjacent fat plane along with irregular nodal margin indicates extra capsular spread. Among head and neck cancer patients, extra capsular spread is considered as a pathological marker of poor prognosis. Increased number of nodal metastasis, regional recurrences and metastasis-are all associated with it.[12]

Akoglu et al observed a sensitivity of 77.7%, specificity 85.7%, positive predictive value of 91.3%%, negative predictive value of 66.6% and accuracy of 80.4%.[13]

Diagnosis and staging of cervical lymph node metastasis, is usually done on CT and MRI. Even though they have varied sensitivity and specificity.

PET/CT is superior to MRI and CT for the assessment of cervical, supraclavicular, mediastinal lymph node involvement anddistant metastasis.

For cervical lymph node enlargement and staging PET/CT is used. In advanced stage subjects, PET/CT is primarily used for evaluating nodal involvement and systemic metastasis.[8]

COLOUR DOPPLER ULTRASOUND SCAN

Ultrasonic radiography (USG) alone cannot accurately determine the etiology of cervical lymphadenopathy, still due to its wide availability and cost effectiveness it is routinely used. The diagnostic accuracy of ultrasound is enhanced by color Doppler; however, its routine usage is considerably decreased due to its inconsistent results and poor reliability.[5]

Doppler helps evaluate the type and intensity of nodal blood flow. The various types of lymph node vascularity are 1) Hilar: Vascular signals limited to lymph node hilum, 2) Peripheral: Vascular signals distributed around the node, 3) Mixed: More than one type of pattern.[14,15]

Peripheral or mixed vascularity is usually found in majority of the metastatic lymph nodes. Production of tumor angiogenic factors is the cause of peripheral vascularity, thus resulting in angiogenesis and recruitment of peripheral vessels.[15-18]

CONTRAST ENHANCED ULTRASONOGRAPHY

Benign and metastatic superficial lymph nodes (LNs) are distinguished using a new technique, the contrast enhanced ultrasound (CEUS). This can be done with accuracy. Moreover micro vascular network blood flow can be monitored.

Intravenous contrast agents are used in CEUS, for qualitative and quantitativestudies.

Rubaltelli 2004 retrospective study, evaluated 56 suspicious lymph nodes-31 cervical lymph nodes and other lymph nodes from various locations. They interpreted, for diagnosing malignancy, CEUS using SonoVue and harmonic imaging, were found to be 92% specific and 93%sensitive. In homogenous nodal enhancement is a feature of malignancy - this has been reflected by CEUS.[19]

The Dudau et al study revealed that for the differentiation between benign and malignant lymph nodes, conventional ultrasound has certain limitations.

Despite having only 22 nodes to evaluate compared to 25 for a conventional ultrasound study, CUS was found to be more sensitive (100%) in detecting malignancy. This was attributed to the fact, that three lymph nodes revealed no enhancement at all which probably was due to a technical issue with the ultrasound.[20] Even in the worst possible scenario, if the three lymph nodes were all false negatives, still CEUS is superior to conventional US, as the sensitivity increases to 83.3% and its accuracy to 87.5%.[19-21]

Sonoelastography, a non-invasive modality has recently become popular for differentiating benign and malignant lymph nodes. However; due to its operator dependency it is not widely used.[19]

Sonoelastography can be used for pathologic diseases such as cancer and fibrosis as here the tissue elasticity is modified.[22]

Sonoelastogram is operator dependent due to a variety of reasons. 1) Dynamic electrogram may appear unsteady because of the processing artifacts. Genuine tissue displacement may occur in the imaging window. During compression relaxation cycles or tissue motions when bulk tissue movement occurs, electrogram can be stabilized using software temporal and spatial averaging techniques. It basically signifies, the selection of a static image from a dynamic series, proves to be a difficult task in clinical practice. 2) Qualitative interpretation of elastogram is subjective. 3) Many tissues are spatially heterogeneous on sonoelastogram thus complicating further the subjective selection of representative measurements.[22,23]

CT PERFUSION IMAGING

CT perfusion (CT) and DWI -MRI, are the newer functional radiological modalities. On comparison with the rest of the imaging techniques, they have a higher and better specificity and sensitivity. The advent of multi-detector row computed tomography (MDCT), in the last decade, allows fast scanning and decreased scan time compared to MRI. Thus, it has facilitated the functional parameter evaluation in squamous cell carcinoma such as the integration of tissue perfusion with the morphological information derived from conventional cross sectional imaging techniques. For the quantitative assessment of tissue microcirculation, a dynamic contrast enhanced technique-perfusion imaging is used.[24,25]

Through neovascularity, malignant tumors can sustain their rapid growth, wrt the normal tissues. The new vessels in the tumor have different hemodynamics, thus facilitating the assessment of local extent of malignant growth. This is done through the neovascularity tracing against the background of normal tissue circulation. Perfusion imaging techniques performed using CT and MRI, help in studying the neovascularity in tumors. The use of the dynamic injection of intravenous contrast facilitates the study of changes in tumor intensity on MRI and attenuation on CT. Various mathematical models of flow, help in studying the numerous aspects of vascularity namely blood flow (BF), blood volume (BV),

capillary permeability (CP) and mean transit time (MTT).[25,26]

Computed tomography perfusion parameters

Blood volume (BV) is defined as the total volume of blood in a given unit volume of the lymph nodes. This definition includes blood volume has units of Milli liters of blood per 100 gm (ml/100g).[25,26]

Blood flow (BF) is defined as the volume of blood moving through a given unit volume of lymph nodes per unit time. BF has units of ml of blood per 100 gm per minute (ml/100g/min).[25,26]

Mean transit time (MTT) is defined as the average of the transit time of blood through a given lymph nodes region. MTT is related to both BV and BF according to the central volume principle, which states that MTT=BVIBF.[25,26]

Permeability surface (PS) is defined as the flow of molecules through capillary membranes in certain volume of tissue. PS has unit of (ml/100g/min).[25,26]

The 18F-FDG PET, diffusion weighted MRI (DWI), perfusion imaging with dynamic contrast -enhanced MRI (DCE-MR1), CT perfusion-are some of the other techniques employed for examining cervical lymph nodes. Nowadays, in clinical practice FDG PET is commonly used. On comparing various imaging modalities-FDG PET with CT, MRI, or sonography in a Meta analysis, increased sensitivity (from 79% to 85%) and increased specificity (80% to 86%) for nodes was revealed by FDG PET.

To differentiate benign from malignant lymph nodes, PET and SPECT may be used, but they have a high cost, are less readily available and have a low specificity. On comparing the newer functional radiological modalities namely CT PERFUSION (CP), and DWI MRI with the rest of conventional radiological imaging modalities - the newer techniques have a higher and superior sensitivity and specificity.[5]

RECENT MODALITIES

For the early diagnosis of head and neck malignant tumors, Narrow band imaging (NBI) is an essential tool. It facilitates the early-stage diagnosis of HNSCC and evaluating the prognosis. Enhanced image contrast in superficial mucosal lesions is reflected by NBI, specifically the highlighting of the micro vasculature thus determining the nature of the lesion. This helps, taking into consideration the minimally invasive treatment option.[28,29]

Hopkins rod- lens telescopes, direct laryngoscopes, flexible endoscopes, and micro laryngoscopic visualization techniques have been used for the detailed clinical examination of the parameters of mucosal lesions i.e. color, contour and extent of the lesion. However, during clinical examination, the use of these methods is limited to providing pathological information only. The detailed examination and provision of pathological information of mucosal lesions have been facilitated with the advent of advanced optical imaging detection techniques namely narrow band imaging (NBI), contact endoscopy and OCT.[30,31]

CONCLUSION

Appropriate imaging of the malignancies of the head and neck determines the extent of the primary lesion, local encroachment, pattern of nodal metastasis and likely prognosis. Moreover, this dictates intervention, surgical, radiotherapeutic or medical as the case maybe.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Vigneswaran N, Williams MD. Epidemiologic Trends in Head and Neck Cancer and Aids in Diagnosis. Oral Maxillofac Surg Clin North Am. 2014;26(2):122-41.
2. Siddiqui MS, Chandra R, Aziz A, Suman S. Epidemiology and histopatndagea spectrum of head and neck cancers in Bihar, a state of Eastern India, Asian Pac. J Cane Prev. 2012;13(8):3949-53.
3. Gilyoma JM, Rambau PF, Masalu, Kayange NM, Chalya PL. Head and neck cancer, a clinico - pathological profile and management challenges in a resource- limited setting. BMC Res Notes. 2015;8:772.
4. Vishwanath V, Jafarie S. The role of imaging in head and neck cancer: An overview of different imaging modalities in primary diagnosis and staging of the disease. 2020;(5):512-8.
5. Ong CK, Chong VF. Imaging of perineural spread in head and neck tumours. Cancer Imaging. 2010;10A(1A):S92-8.
6. Gage KL, Thomas K, Jong D, Stallworth DG, Arrington JA. Multimodal Imaging of Head and Neck Squamous Cell Carcinoma. Cancer Control. 2017;24(2):172-9.
7. Abraham J. Imaging for head and neck cancer. Surg Oncol Clin N Am. 2015;24(3):455-71.
8. Lewis-Jones H, Colley S, Gibson D. Imaging in head and neck cancer: United Kingdom National Multidisciplinary Guidelines. J Laryngol Otol. 2016;130(S2):S28-31.
9. Wippold FJ 2nd. Head and neck imaging: the role of CT and MRI. J Magn Reson Imaging. 2007;25(3):453-65
10. Sönmez A, Oztürk N, Ersoy B, Bayramigli M, Celebiler O. Computed tomography in the management of cervical lymph node pathology. J

Plast Reconstr Aesthet Surg. 2008;61(1):61-4.
11. King AD, Tse GMK, Ahuja AT, Yuen EHY, Vlantis AC. Necrosis in metastatic neck nodes: diagnostic accuracy of CT, MR imaging, and US. Radiology. 2004;230(3):720-6.
12. Myers JN, Greenberg JS, Mo V, Roberts D. Extracapsular spread. A significant predictor of treatment failure in patients with squamous cell carcinoma of the tongue. Cancer. 2001;92(12):3030-6.
13. Becker M, Zaidi H. Imaging in head and neck squamous cell carcinoma: the potential role of PET/MRI. Br J Radiol. 2014;87(1036):20130677.
14. Cui XW, Jensen C, Saftoiu A, Ignee A, Dietrich CF. New ultrasound techniques for lymph node evaluation. World J Gastroenterol 2013;19(30):4850-60.
15. Ahuja AT, Ying M. Evaluation of cervical lymph node vascularity: a comparison of colour Doppler, power Doppler and 3-D power Doppler sonography. Ultrasound Med Biol. 2004;30(12):1557-64.
16. Ahuja AT, Ying M, Ho SY, Antonio G, Lee YP. Ultrasound of malignant cervical lymph nodes. Cancer Imaging. 2008;8(1):48-56.
17. Ying M, Bhatia KS, Lee YP, Yuen HY, Ahuja AT. Review of ultrasonography of malignant neck nodes: greyscale, Doppler, contrast enhancement and elastography. Cancer Imaging. 2014;13(4):658-69.
18. Pattanayak S, Chatterjee S, Ravikumar R, Nijhawan VS, Sharma V et al. Ultrasound evaluation of cervical lymphadenopathy: Can it reduce the need of histopathology/cytopathology? Med J Armed Forces India 2018;74(3):227-34.
19. Rubaltelli L, Khadivi Y, Tregnaghi A, Stramare R, Ferro F. Evaluation of lymph node perfusion using continuous mode harmonic ultrasonography with a second-generation contrast agent. J Ultrasound Med. 2004;23(6):829-36.
20. Dudau C, Hameed S, Gibson D, Muthu S, Sandison A. Can contrast enhanced ultrasound distinguish malignant from reactive lymph nodes in patients with head and neck cancers? Ultrasound Med Biol. 2014;40(4):747-54.
21. Rubaltelli L, Beltrame V, Scagliori E, Bezzon E, Frigo AC. Potential use of contrast-enhanced ultrasound (CUS) in the detection of metastatic superficial lymph nodes in melanoma patients. Ultraschall Med. 2014;35(1):67-71.
22. Bhatia KS, Lee YY, Yuen EH, Ahuja AT. Ultrasound elastography in the head and neck. Part I. Basic principles and practical aspects. Cancer Imaging. 2013;13(2):253-9.
23. McQueen AS, Bhatia KS. Head and neck ultrasound: technical advances, novel applications and the role of elastography. Clin Radiol. 2018;73(1):81-93.
24. Petralia G, Bonello L, Viotti S, Preda L, d'Andrea G, Bellomi M. CT perfusion in oncology: how to do it. Cancer Imaging. 2010;10(1):8.
25. Preda L, Calloni SF, Moscatelli ME, Cossu Rocca M, Bellomi M. Role of CT perfusion in monitoring and prediction of response to therapy of head and neck squamous cell carcinoma. BioMed Res Int. 2014;2014.
26. Bisdas S, Baghi M, Wagenblast J, Knecht R, Thng CH, Koh TS, Vogl TJ. Differentiation of benign and malignant parotid tumors using deconvolution-based perfusion CT imaging: feasibility of the method and initial results. Eur J Radiol. 2007;64(2):258-65.
27. Kyzas PA, Evangelou E, Denaxa-Kyza D, Ioannidis JP. 18F-fluorodeoxyglucose positron emission tomography to evaluate cervical node metastases in patients with head and neck squamous cell carcinoma: a meta-analysis. J National Cancer Institute. 2008;100(10):712-20.
28. Ni XG, Wang GQ. The role of narrow band imaging in head and neck cancers. Curr Oncol Rep. 2016;18:1-7.
29. Tan NC, Herd MK, Brennan PA, Puxeddu R. The role of narrow band imaging in early detection of head and neck cancer. Brit J Oral Maxillofacial Surg. 2012;50(2):132-6.
30. Dowthwaite S, Szeto C, Wehrli B, Daley T, Whelan F, Franklin J et al. Contact endoscopy as a novel technique in the detection and diagnosis of oral cavity and oropharyngeal mucosal lesions in the head and neck. J Laryngol Otol. 2014;128(2):147-52.
31. Green B, Tsiroyannis C, Brennan PA. Optical diagnostic systems for assessing head and neck lesions. Oral Diseases. 2016;22(3):180-4.

Cite this article as: Munjal M, Munjal S, Saggar V, Kaur H, Arora V, Sandhu L et al. Imaging in head and neck cancers: a review. Int J Otorhinolaryngol Head Neck Surg 2023;9:772-6.