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The role of imaging in head and neck cancer

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ABSTRACT
In this article, the importance of imaging, imaging characteristics, and the significance of several imaging modalities—as well as more recent imaging modalities—are discussed in relation to the assessment of head and neck cancer. Imaging tests are conducted as part of the pretreatment evaluation largely to ascertain the tumor's stage and search for an occult primary. If radiotherapy is being considered, it aids in planning the treatment and getting tissue samples to determine the diagnosis. Imaging can distinguish between postoperative and radiation alterations and persistent or recurrent disease. When evaluating the effectiveness of a treatment, imaging is also crucial.
Keywords: Head and neck cancer (HNC), magnetic resonance imaging (MRI), positron emission tomography (PET), ultrasonography (USG), squamous cell carcinoma (SCC), computed tomography (CT).

INTRODUCTION

Squamous cell carcinoma (SCC) is the primary group of malignancies that arise from a range of sites and is included in head and neck cancer (HNC).

- Thyroid,
- Larynx,
- Nasal cavity and paranasal sinuses,
- Lips, buccal mucosa, anterior tongue, floor of the mouth, hard palate, retromolar trigone, tongue, and upper and lower gingiva make up the oral cavity.
- Oropharynx, nasopharynx, and hypopharynx are the three parts of the pharynx.
- Skull base
- Salivary glands, both large and small.

The majority of head and neck malignancies are SCC. Adenocarcinomas, adenoid cystic carcinomas, mucoepidermoid carcinomas, and metastases are examples of other cancers. Leukemia, melanoma, lymphoma, and sarcomas are examples of mesenchymal tumours. Some cancers, like esthesioneuroblastoma, are localised only in certain areas (olfactory neuroblastoma).

Method for separating solid from cystic lesions and for examining exposed structures, particularly the thyroid and lymph nodes. It is affordable, portable, and easily accessible. Ultrasonography, however, struggles to identify the deeper diseases. The cross-sectional modalities CT and MRI can be used to more accurately assess the full extent of the pathology Due to its inherent improved soft tissue contrast and lack of radiation, MRI is preferable in certain circumstances.

The advantage of CT is its superiority in detecting minute bone cortical erosion and calcification. When paired with structural imaging modalities, functional information from PET and radionuclide imaging aids in a better assessment of pathology.

NASAL CAVITY AND PARANASAL SINUS (PNS) CANCERS

For 3% of head and neck malignant neoplasms, sinonasal tumours are cancerous. [1] The most typical histological subtype of PNS cancers is squamous cell carcinoma. In addition, there are adenocarcinomas, adenoid cystic carcinomas, mucoepidermoid carcinomas, and olfactory epidermal neuroblastomas. The maxillary sinus is the one that is most frequently affected. The degree of involvement of nearby structures by the pathology is assessed using cross-sectional imaging techniques like CT and MRI. Since orbital invasion modifies management, it is crucial to find it early. It is possible to tell if there has been an invasion of the orbit by looking for extraocular muscle expansion, orbital fat involvement, or signal changes. A frozen biopsy is advised in cases of diagnostic uncertainty because no single criterion is extremely accurate. [2]

MRI aids in distinguishing between a tumour and secretions. It is the most effective method for evaluating intracranial extension. The most reliable method for identifying dural involvement is contrast-enhanced MRI in various planes, which is observed as augmenting thick, uneven, nodular dura as well as involvement of brain parenchyma. MRI provides a more accurate assessment of cavernous sinus involvement and perineural dissemination. [3] It's crucial to check for perineural spread from adenoid cystic carcinoma through the foramen ovale, rotundum, and vidian canal to the skull base and central nervous system (CNS).

After surgery, a biopsy should be done if the cavity or the graft's margins exhibit nodulism, irregularity, or thickness. [4] When detecting post-therapeutic tumour recurrence, PET-CT is more accurate. The neural crest is the source of olfactory neuroblastoma (esthesioneuroblastoma). It comes from the nasal cavity's olfactory epithelium. It appears as a tumour in the nasal cavity that is uniformly enhancing and spreads to the maxillary and ethmoid sinuses. It could extend inside the skull. The presence of peripheral tumoral cysts with a broad base strongly suggests this tumour. [5]

THYROID CANCER

Papillary, follicular, medullary, and anaplastic carcinomas are among the thyroid tumours. Squamous cell carcinomas and lymphomas are uncommon. Thyroid metastatic disease has also been documented. There are numerous imaging techniques available to evaluate thyroid carcinoma. Ultrasonography is the first imaging modality used. It aids in separating solid from cystic tumours, searching for coexisting nodules, and guiding biopsy procedures for both nodules and lymph node metastases. Imaging may occasionally fail to distinguish between benign and malignant tumours. [6] It is important for the follow-up of individuals who have had papillary carcinoma treatment. The presence of a solid nodule with microcalcification, the absence of a halo, and internal vascularity are characteristics that indicate malignancy. [7] The society of radiologists has only produced a few suggestions about ultrasonography therapy of thyroid nodules that require FNAC. [8]

One drawback of ultrasonography is the difficulty in determining the full extent of a lesion, particularly in deeper tissues like the substernal region and deeper paratracheal tissues. [9] In this respect, CT and MRI are superior. Gadolinium-based MR contrast

media do not interfere with the diagnostic or therapeutic iodine uptake, in contrast to the CT iodinated contrast media, which interfere with the iodine metabolism for at least 6 weeks. These benefits of MRI over CT go beyond the usual advantages of soft tissue resolution and lack of radiation. [10]
Functional information is provided through radionuclide imaging. It is used to identify leftover thyroid tissue after surgery, to distinguish between cool and hot nodules, and to identify metastatic, recurring, and residual disease. The suggestion for postoperative surveillance of thyroid cancer patients, however, is ultrasonography in conjunction with serum thyroglobulin determination due to the low sensitivity of diagnostic radionuclide imaging. [11] Low iodine uptake tumours with limited differentiation can be found with PET. [12]

LARYNGEAL CANCER

As the mucosal surface can be observed on a laryngoscopy, the aim of radiology in imaging laryngeal cancer is to discover involvement of the submucosa and also tissues beyond it. [13] Additionally, it aids in the detection of cancer in areas that are difficult to see with endoscopy, such as cartilage, the deep ventricle, and extralaryngeal dissemination with nodal and systemic metastases. The cross-sectional imaging modalities used to assess laryngeal cancer are CT and MRI. Along with the standard CT protocol, imaging may also be performed using techniques like e-phonation to evaluate the laryngeal ventricle, the anterior commissure, and the aryepiglottic folds, or modified valsalva to more accurately examine the pyriform sinus and postcricoid region. [14]

It is crucial to identify the inferior border of supraglottic tumours because the paraglottic space and ventricle must not be affected for supraglottic laryngectomy to be effective. Imaging is useful in establishing whether the tongue base, an endoscopic blind area, is involved. [15] Determining the cricoid cartilage involvement and inferior border of the lesion in glottic tumours is crucial because it affects the surgical approach. Paraglottic space invasion is significant because it may expand to the subglottic or supraglottic regions. Involvement of the anterior commissure should be suspected in laryngeal carcinoma. The soft tissue in the vicinity of the anterior commissure should typically only be 1 to 2 mm thick. [16] The presence of soft tissue on either side of the cartilage, the presence of erosion, or changed attenuation within the medullary cavity are all indicators of laryngeal cartilage involvement. Bone windows should be examined to check for laryngeal cartilage involvement. In cases when CT results are ambiguous, laryngeal cartilage involvement is evaluated using MRI in order to better characterise the tumor's margins. The elevated signal on T2 weighted MR imaging, however, is not specific and could be caused by reactive change even without tumour involvement. [17]

ORAL CAVITY, TONGUE AND OROPHARYNGEAL CANCER

The majority of malignant lesions of the oral cavity and oropharynx are superficial, poorly defined, invasive, and devoid of calcification. On T1WI, these are isointense to muscle, and on T2WI, they are hyperintense with varying augmentation. Malignancy is characterised by perineural spread, invasion, and bone damage. [18] The most common imaging technique is CT, while there are instances when MRI is beneficial. Mandible involvement has therapeutic implications. Clinically useful, inexpensive, and unaltered by dental amalgam artefacts, panoramic images of the mandible are available. [19]

MRI ought to be the first imaging technique used in tongue cancer. A CT scan should be performed if mandibular involvement is suspected. The therapeutic implications of extension into the geniohyoid and genioglossus muscles and extension across the median raphe are that they suggest that the entire tongue may be involved. MRI provides a more accurate clinical assessment of lesions that are restricted to the anterior tongue, allowing these patients to undergo partial glossectomy. [20]

NASOPHARYNGEAL CANCER

Imaging aids in the planning and staging of treatment. CT and MRI work in conjunction to stage nasopharyngeal carcinoma. By detecting early pharyngobasilar fascia invasion, MRI aids in identifying the dissemination of the tumour to the parapharyngeal space and more accurately portrays the perineural spread, which affects staging. [21] While modest cortical erosion is better visible on CT, MRI aids in the diagnosis of marrow involvement. With the help of these cross-sectional imaging techniques, the tumor's penetration into the nearby structures can be accurately assessed.

SKULL BASE CANCER

Imaging is crucial in evaluating skull base lesions because it is a challenging location to assess clinically. It aids in determining the severity of the injury, particularly when there is slight bone involvement and continuous intracranial extension. While MRI is better for looking for involvement of bones like the clivus, petrous apex, sphenoid bone, and pterygoid process, CT is more beneficial for looking for involvement of thin cortical bone. Due to marrow involvement, [22] MRI displays T1 hypointense signal with loss of normal intermediate signal intensity fatty marrow. The aberrant marrow exhibits improvement as well.

SALIVARY GLAND CANCERS

The imaging modalities of CT and MRI are used to examine the tumor's extent, particularly when it involves the deep lobe of the parotid gland and causes erosion of the mandible or skull base. MRI is the preferred imaging technique since it can more clearly determine the lesion's borders and characteristics. However, whereas calcification might serve to restrict the differential diagnosis of salivary gland diseases, MRI may not be able to detect it, making CT the preferred modality.[23]

Evaluation of Lymphadenopathy

An important prognostic factor in the treatment of head and neck malignancies is lymph node metastasis. [24] Imaging has a significant role in finding nodes in a significant number of individuals when a clinical evaluation for nodes is negative. [25] A lymph nodal classification system based on imaging has been suggested for better reproducibility of node localization. [26]

Imaging for Distant Metastases

At presentation, distant metastases are often uncommon. The incidence is influenced by the tumor's initial T and N stages, as well as its primary site. Metastases to the lungs are more frequent. The other, less frequent sites are metastases to the bone, liver, mediastinum, and skin. In every situation, preoperative chest radiography is performed. Those at high risk for developing pulmonary metastases frequently undergo a CT of the chest.[27]

Role of Fusion Imaging: PET-CT

The basis for PET imaging is the idea that highly metabolically active tissues absorb more glucose. Both anatomical and metabolic data are provided by PET-CT. It is a method that combines the benefits of both PET and CT. In the diagnosis of head and neck cancer, PET-CT is unquestionably more reliable than PET or CT alone and boosts the radiologist's confidence.

Role of Imaging in Planning Radiotherapy

By providing a three-dimensional image of the tumour volume and the organs that are at danger, CT and MRI imaging aid in the precise positioning of the radiation portals that will target the tumour and shield the surrounding organs. The CT's information on electron density aids in changing the dose. [28] However, dental fillings weaken CT pictures and the contrast resolution is worse. MRI's inherent soft tissue contrast makes it easier to distinguish between normal and diseased tissue, which aids in precise planning. [29]

Functional imaging techniques like PET, PET-CT, MR spectroscopy, and dynamic contrast enhanced studies help to better localise the tumour, measure its size, and identify areas that are radioresistant due to hypoxia or accelerated proliferation. This allows the radiation technique or dose to be changed.[28]

CONCLUSION

In conclusion, imaging is crucial for the staging of head and neck malignancies, which affects the available treatments. Depending on the circumstance, different imaging modalities have different superiorities. Ultrasonography is helpful in assessing superficial diseases, particularly those involving the thyroid and lymph nodes. The extent of pathology can be better seen with CT and MRI. Tissue samples can be collected via imaging in order to make a diagnosis. CT and MRI can be used to plan radiotherapy. Imaging is crucial in determining how well a treatment is working. The functional data is provided by PET and radionuclide imaging.

PET-CT is particularly helpful in post-therapeutic evaluation to identify treatment-induced alterations and recurrent or persistent disease with high negative predictive value due to the combined benefit of structural and functional imaging elements.

REFERENCES

1. Boring CC, Squires TS, Tong T. Cancer Statistics CA 1992;42:19- 38.
2. Eisen MD, Yousem DM, Loevner LA, et al. Preoperative imaging to predict orbital invasion by tumor. Head Neck 2000;22:456- 62.
3. Eisen MD, Yousem DM, Montone KT, et al. Use of preoperative MR to predict dural, perineural and venous sinus invasion of skull base tumors. Am J Neuroradiol 1996;7:1937- 45.
4. Tomura N, Watanabe O, Hirano Y, et al. MR imaging of recurrent head and neck tumours following flap reconstructive surgery. Clin Radiol 2002;57:109-13.
5. Som P, Lidov M, Brandwein M, et al. Sinonasal esthesioneuroblastoma with intracranial extension: Marginal tumor cysts as a diagnostic MR finding. Am J Neuroradiol 1994;15:1259-62.
6. Som PM, Crutin HD. Head and neck imaging (4th ed.) St Louis: Mosby 2003;2131-71.
7. Solbiati L, Livvaghi T, Ballarati E, et al. Thyroid gland. In Solbiati L, Rizzatto G (Eds): Ultrasound of superficial structures. Edinburgh, Churchill Livingstone 1995;49-85.

8. Muammer Urhan, Murat Velioglu, Joshua Rosenbaum, Sandip Basu and Abass Alavi.Imaging for the diagnosis of thyroid cancer. Expert Opin. Med. Diagn 2009;3(3):237-49.
9. King AD, Ahuja AT, To EW, et al. Staging papillary carcinoma of the thyroid: Magnetic resonance imaging vs ultrasound of the neck. Clin Radiol 2000;55:222-26.
10. Asako Miyakoshi, Robert W. Dalley and Yoshimi Anzai. Magnetic Resonance Imaging of Thyroid Cancer. Topn Magn Reson Imaging 2007;18:293-302.
11. Mazzaferri EL, Kloos RT. Is dagnostic iodine-131 scanning with recombinant human TSH useful in the follow-up differentiated thyroid cancer after thyroid ablation? J Clin Endocrinol Metab 2002;87:1490-98.
12. Iagaru A, Kalinyak JE, McDougall R. F-18 FDG PET/CT in the management of thyroid cancer. Clin Nucl Med 2007;32:690- 711.
13. Steve Connor. Laryngeal cancer: How does the radiologist help? Cancer Imaging 2007;7(1):93-103.
14. Philippe Henrot, Alain Blum, Bruno Toussaint, Philippe Troufleau, Joseph Stines, Jacques Roland. Dynamic Maneuvers in Local Staging of Head and Neck Malignancies with Current Imaging Techniques: Principles and Clinical Applications. RadioGraphics 2003;23:1201-13.
15. Janet E Husband, Rodney H Reznek. Imaging in oncology (2nd ed.) Taylor and Francis 2004;639-67.
16. Som PM, Crutin HD. Head and neck imaging (4th ed.) St Louis: Mosby 2003;1595-699.
17. Castelijns J, Hermans R, van den Brekel M, Mukherji S. Imaging of laryngeal cancer. Semin Ultrasound CT MR 1998;19:492- 504.
18. Hilda E. Stambuk, Sasan Karimi, Nancy Lee, et al. Oral cavity and oropharynx tumors. Radiol Clin N Am 2007;45:1-20.
19. Shaha AR. Preoperative evaluation of the mandible in patients with carcinoma of the floor of the mouth. Head Neck 1991;13:398- 402.
20. Robert Sigal, Anne-Marie Zagdanski, Guy Schwaab, et al. CT and MR Imaging of Squamous Cell Carcinoma of the Tongue and Floor of the Mouth RadioGraphics 1996;l6:78-81.
21. Janet E Husband, Rodney H Reznek. Imaging in oncology (2nd ed), Taylor and Francis 2004;607-38.
22. Chong VF, Fan YF. Detection of recurrent nasopharyngeal carcinoma: MRI vs CT. Radiology 1997;202:463-70.
23. Som PM, Crutin HD. Head and neck imaging (4th ed). St Louis: Mosby 2003;2005-133.
24. Johnson JT. A surgeon looks at cervical lymph nodes. Radiology 1990;175:607-10.
25. Atula TS, Varpula MJ, Kurki TJ, et al. Assessment of cervical lymph node status in head and neck cancer patients: Palpation, computed tomography and low field magnetic resonance imaging compared with ultrasound-guided fine-needle aspiration cytology. Eur J Radiol 1997;25:152-61.
26. Som PM, Crutin HD. Head and neck imaging. (4th ed). St Louis: Mosby 2003;1865-1934.
27. Ferlito Alfio, Shaha Ashok R, Silvery Carl E, Rinaldo Alessandra, Mondin Vanni. Incidence and sites of distant metastases from head and neck cancer. ORL 2002;63(4):202-07.

28. K Newbold, M Patridge, G Cook, et al. Advanced imaging applied to radiotherapy planning in hed and neck cancer: A clinical review. Br J Radiol 2006;79:554-61.
29. Khoo VS, Dearnaley DP, Finnigan DJ, Padhani A, Tanner SF, Leach MO. Magnetic resonance imaging (MRI): Considerations and applications in radiotherapy treatment planning. Radiother Oncol 1997;42:1-15.