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Review article

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VALUE OF IMAGING STUDIES IN THE STAGING AND FOLLOW-UP OF HEAD AND NECK SQUAMOUS CELL CARCINOMA

SUMMARY

Imaging methods assist in the treatment planning of head and neck neoplasms by better defining the local extension of infiltrating tumours and by detecting subclinical neck adenopathies. Imaging has also an important role in excluding or detecting distant metastasis. The imaging findings are helpful in determining the optimal therapy, and in identifying patients at high risk for recurrence to be followed up more closely. Imaging can be used to monitor tumour response and to try to detect recurrent or persistent disease before it becomes clinically evident, possibly with a better chance for successful salvage.

Key words: **imaging, follow-up, squamous cell carcinoma, head, neck**

INTRODUCTION

After skin cancer, squamous cell carcinoma (SCC) is the second most common cancer of the head and neck region, arising from the mucosal layers.

Malignant neoplasms may also originate from the numerous glands in the head and neck; these tumours are most commonly of thyroid gland or salivary gland origin.

Lymphoma, limited to the head and neck region, is not very common; head and neck lymphoma is usually a manifestation of systemic lymphoma.

Different types of sarcomas, as well as tumours arising from neuro-ectodermal tissues (such as olfactory neuroblastoma, neuroendocrine carcinoma, malignant melanoma…) may be encountered in the head and neck.

Most imaging studies for head and neck malignancies are performed for the evaluation of SCC. The content of this review article is therefore focused on this disease.

Squamous cell carcinoma

Smoking and excessive alcohol consumption are well-known risk factors in head and neck SCC. Especially when combined, the risk for developing such a neoplasm in the upper aerodigestive tract is dramatically increased.

SCC of the head and neck is a very heterogeneous disease. The symptoms, the treatment and the prognosis are clearly influenced by the site of origin. These sites determine, by their particular anatomy, the local extension pattern of the cancer. They also determine the risk of lymphatic dissemination, as well as the localisation of the metastatic neck nodes.

Also, the biological behaviour of these cancers is determined by their site of origin. For example, nasopharyngeal cancer is more responsive to radiotherapy than other head and neck cancers. Also, within the same anatomical site, a variable, treatment response is observed between different patients, only partly predictable by the T-category. A difference in tumour volume between patients is one of the factors that contribute to this variability in

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treatment response (1,2).

As SCC is a mucosal disease, in many patients the diagnosis is made by inspection, revealing an abnormality of the mucous membrane. However, these tumours do have the tendency to spread submucosally, and such deep extension may be impossible to detect by clinical examination. Perineural and/or perivascular spread, eventually leading to tumour progression or recurrences at distance from the primary tumour, can be detected by imaging. Bone involvement can be visualised using CT or MRI, and also metastatic adenopathies can be identified, sometimes still in a subclinical stage or at places not accessible for clinical examination. All these imaging findings can profoundly influence the staging and management of a patient with SCC.

Imaging techniques

Several techniques are available to visualize head and neck cancer, each having advantages and disadvantages.

In many patients, computed tomography (CT) is the most appropriate imaging tool. This technique is widely available, and can be executed relatively easy at a relative low cost. It allows visualizing the entire neck in a short examination time, and provides superior bone detail. Nowadays, the standard is multidetector CT; apart from even faster data acquisition, this technique also allows retrospective reformatting of the axial images in other planes.

Alternatively, magnetic resonance imaging (MRI) can be used. MRI has a superior soft tissue contrast resolution, and does not require the injection of an iodinated contrast agent. MRI is also less affected by the presence of dental amalgam in the oral cavity. However, motion artefacts frequently degrade the image quality obtained with MRI, sometimes resulting in a non-conclusive examination.

CT and MRI are not competing, but complementary imaging modalities. The choice of the imaging modality depends on the localisation of the primary tumour. CT is preferred for the examination of cancers of the larynx, hypopharynx, oral cavity and oropharynx, while MRI is better suited to visualize nasopharyngeal, sinonasal and skull base tumours (3,4).

Ultrasound, in combination with fine needle aspiration cytology (FNAC), is used in some institutions to stage nodal disease (5).

PET and PET/CT have known a significant increase of use during the last years, mainly to evaluate the presence of distant metastasis or second primary tumours (6). However, these are expensive modalities, not widely available. As most head and neck SCC first metastasize to the lungs, chest CT can be used as an alternative for ruling out distant disease in patients with risk factors for developing metastasis (7).

Value of imaging before treatment of head and neck squamous cell cancer

Primary tumour

As mentioned, in most cases the clinician knows there is cancer, so imaging is not performed to diagnose cancer, but to show the submucosal extension of the lesion. Imaging criteria used for tumour involvement are abnormal contrast enhancement, soft tissue thickening, presence of a bulky mass, infiltration of fatty tissue (even without distortion of surrounding soft tissues), or a combination of these (Figure 1). However, small foci of mucosal tumour may be difficult to detect or may be invisible, and associated inflammatory and oedematous changes may cause overestimation of the tumour extent (3).

Gross cartilage or bone invasion can be detected using CT (Figure 1).

A

B

Figure 1. Axial CT images in a patient suffering squamous cell cancer of the anterior mandibular alveolar process.
A. An enhancing soft tissue lesion (arrowheads) is seen on top of the alveolar process.
B. Similar level, bone window; invasion of the mandibular bone along the dental sockets (being areas of lesser resistance) is seen.

MRI is more sensitive than CT for detecting cartilage or bone invasion (Figure 2), but less specific.

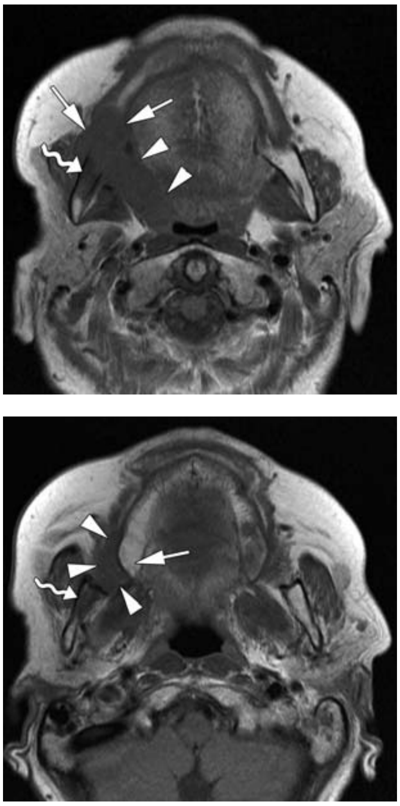

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Figure 2. Axial plain T1-weighted MR images in a patient suffering squamous cell cancer of the right retromolar trigone.
A. A soft tissue mass is seen centred on the retromolar trigone (arrows). The lesion extends in the lateral oropharyngeal wall (arrowheads). Apart from cortical destruction, also signal loss is seen in the mandibular ramus, corresponding to bone marrow involvement (curved arrow).
B. More cranially, the lesion (arrowheads) is seen to extend along the maxillary tuber, which shows normal signal intensity (arrow); also at this level, the mandibular medullary cavity appears abnormal (curved arrow). The patient was treated by chemoradiotherapy, with good response; no evidence of disease, 15 months after end of treatment.

MRI sometimes leads to false positive results, mainly because of the presence of peritumoral inflammation (Figure 3) (8).

Overall, despite some limitations, imaging studies show accurately which structures are involved and where the tumour borders are. This is crucial information, influencing management decisions. If the patient is treated by irradiation, the radiological gross tumour volume determines the volume that will be irradiated. Also, the operability of a patient is determined by imaging findings. Spread of the primary cancer along nerves, possibly into the skull

A

B

C

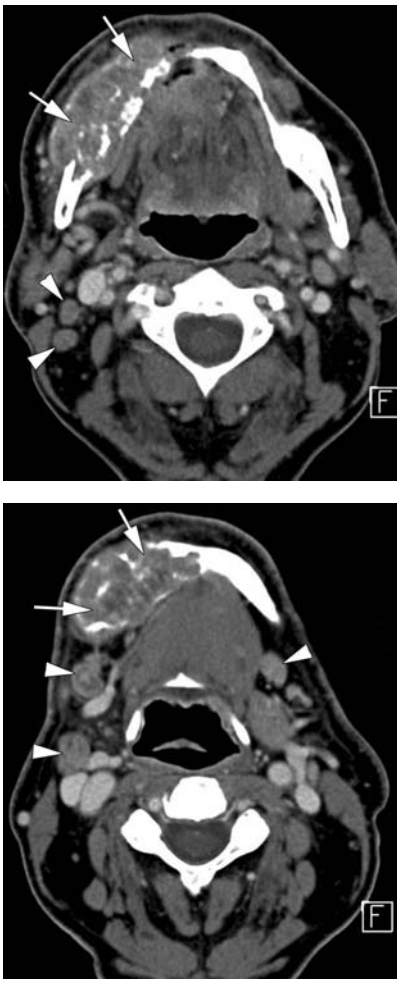
Figure 3. Patient suffering large laryngeal (transglottic) squamous cell cancer.
A. Axial CT-image shows large soft tissue mass in the left hemilarynx, anteriorly extending over the midline. The lesion is adjacent to the ossified thyroid cartilage, not showing any abnormality.
B. Same level. Axial plain T1-weighted spin echo image confirms presence of large laryngeal tumour. The medullary cavity in the ossified thyroid cartilage shows a large area of signal loss on the left side, extending in the anterior part of the right side (arrowheads).
C. Same level. Axial gadolinium-enhanced T1-weighted spin echo image (fat suppressed) shows pronounced enhancement of the tumoral mass in the larynx. Also within the thyroid cartilage pronounced enhancement is seen (arrowheads).
Total laryngectomy was performed, confirming presence of large laryngeal cancer. However, no signs of neoplastic involvement of the thyroid cartilage were histologically found. The signal changes on MRI are presumably due to inflammation.

base, as well as involvement of the large neck arteries, may make resectability uncertain; involvement of the prevertebral space and mediastinum also preclude surgical resection. It is important to note that such tumour spread, involving critical structures, may occur without corresponding clinical symptoms (9).

Nodal metastasis

The presence of nodal metastasis is prognostically very important, essentially reducing the chances of cure by about 50%. The radiological diagnosis of a lymph node metastasis is based on the size of the node, its shape, and the intranodal architecture (such as presence of central nodal necrosis and an irregular nodal border) (10).

Although routine imaging methods are not perfect for nodal staging, the results obtained with these methods are far better than by clinical examination alone (Figure 4).



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B

Figure 4. A-B. Axial CT-images in a patient suffering large squamous cell cancer originating from right mandibular gingiva. Large, heterogeneously enhancing soft tissue mass, invading the mandibular bone is evident (arrows). Several rounded, slightly enlarged lymph nodes are seen, most of them heterogeneously enhancing, ipsilateral in level I and II (submandibular and high parajugular lymph nodes), and contralateral in level I: metastatic adenopathies. These adenopathies were clinically not apparent.

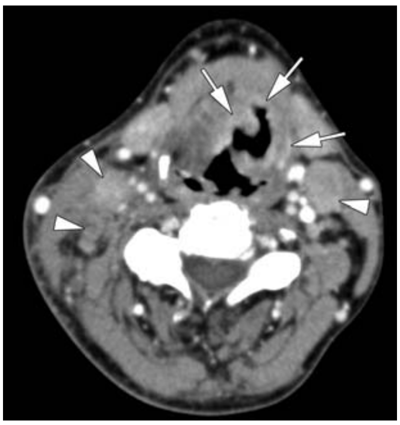
If nodes are present, precise localisation is provided by imaging, allowing treatment planning. In case of positive nodes, evidence of extracapsular tumour growth, with possible invasion of surrounding structures (such as the carotid arteries) should be looked for, as extranodal spread is an indicator of poor prognosis, and its presence may influence patient management.

Distant disease

Finally, imaging is used to exclude or detect the presence of distant metastasis. Most head and neck cancers show distant metastasis only in an advanced stage of disease. The patients are also at risk of developing a second primary tumour, related to long-term tobacco and excessive alcohol exposure.

The search for distant metastasis must be balanced against its costs. The minimal screening for distant metastasis at first presentation should include chest X-ray (11). CT of the chest is the next step when a suspect structure is seen on the plain film.

Chest CT seems also justified in an advanced stage of the primary tumour and/or in the presence of large neck adenopathies, extracapsular tumour spread or the visualisation of neck adenopathies low in the neck. As mentioned above, PET or PET-CT may be used as an alternative technique, when available (Figure 5).



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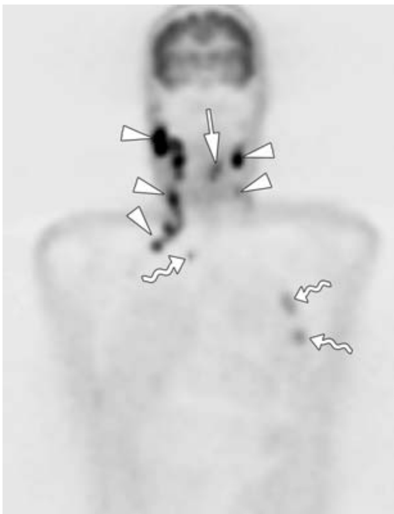

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Figure 5. Patient presenting with advanced supraglottic squamous cell cancer.
A. Axial CT-image shows large, ulcerated mass lesion in the supraglottis on the left side (arrows). Several adenopathies are seen in both sides of the neck (arrowheads); multiple adenopathies were visible throughout the neck on this CT-study. As this patient is at risk of having distant disease, a FDG-PET scan was performed.
B. Coronal FDG-PET image. Apart from the primary tumour (arrow) and the multiple neck adenopathies (arrowheads), several hot spots were seen in the chest (curved arrows), corresponding to distant metastases. Palliative chemotherapy was administered.

Use of imaging after treatment of head and neck squamous cell cancer

Posttreatment CT or MR-imaging is of value when a recurrent tumour is suspected, to confirm the presence of such a lesion and to determine its extent; this is important information for determining the possibility of salvage therapy. On rarer occasions, imaging may be of use in the differentiation between tumour recurrence and treatment complications (12). In patients with a high-risk profile for tumour recurrence after treatment, imaging is of value for surveillance of the patient, as an adjunct to clinical follow-up (13). There is evidence that tumour recurrences can be detected earlier by systematic follow-up imaging than by clinical follow-up alone, and this could lead to more prompt salvage surgery and potentially improve the survival of these patients.

Tumour recurrence appears after radiation therapy as a soft tissue mass at the primary site and/or as a neck adenopathy. After surgical treatment, tumour recurrence typically appears as a soft tissue mass along the surgical resection margins.

Early tumour recurrence may be difficult to distinguish from tissue changes induced by therapy. Therefore, it is recommended to obtain a follow-up

A

B

C

Figure 6. Axial contrast-enhanced CT-images in a patient with a T2N0 supraglottic cancer.
A. Pretreatment image. Left-sided, enhancing infiltrating soft tissue mass in the lower supraglottic soft tissues, abutting the tip of the sclerotic arytenoid cartilage.
B. Baseline follow-up CT study, 4 months after radiotherapy. Clinically no evidence of disease. The tumoral mass disappeared. However, the persistent infiltration in the left retro-arytenoid fat plane (arrow, compare to opposite side, arrowhead) is doubtful. A follow-up CT study was recommended.
C. Eight months after end of radiotherapy. The patient has no symptoms. Clinical examination showed some interarytenoid erythema. On CT, new soft tissue thickening (arrows) is seen surrounding the tip of the arytenoid; this is suspect for tumour recurrence. Direct laryngoscopy was performed, showing edema and some necrotic tissue on the lower left ary-epiglottic fold. Biopsies confirmed presence of cancer. Total laryngectomy was subsequently performed.

CT or MR study after surgical, radiation or combined treatment for a head and neck neoplasm with high-risk profile (13, 14). Probably the best time to obtain such a baseline study is about 3–6 months after the end of treatment. Such a baseline study allows treatment-caused changes in the head and neck tissues to be documented. By comparing subsequent studies with the baseline study, it becomes possible to detect with more confidence tumour recurrences (Figure 6).

Newer developments, such as diffusion-weighted MRI, seem to be helpful in differentiating between treatment-induced tissue changes and tumour recurrence (15).

Some authors recommend FDG-PET as the initial baseline study, in patients treated with advanced disease with low clinical suspicion of recurrence, and in patients with non-specific symptoms that could indicate recurrence but without a clinically obvious mass; cross-sectional imaging should then be performed for an equivocal or positive PET-study, or as the initial study in patients with a suspicious palpable mass or biopsy proved recurrent tumour (16). Further study is needed to elucidate the most efficient use of PET and CT/MR in posttreatment situations.

CONCLUSION

The initial treatment plan for a particular patient suffering head and neck cancer is the result of a multifactorial decision process including tumour extension, tumour staging and volume, patient condition, and patient and institutional preferences. Objective tumour data, as obtained from imaging studies, are helpful to ensure a firm basis for determining prognosis, and for treatment decision making.

Posttreatment imaging is of value when a recurrent tumour is suspected, to confirm the presence of such a lesion and to determine its extent; this is important information for determining the possibility of salvage. On rarer occasions, imaging may be of use in the differentiation between tumour recurrence and treatment complications.

In patients with a high-risk profile for tumour recurrence after treatment, imaging is of value for surveillance of the patient, as an adjunct to clinical follow-up. There is evidence that tumour recurrences can be detected earlier by systematic follow-up imaging.

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ZNAČAJ RADIOLOŠKIH STUDIJA U KATEGORIZACIJI I PRAĆENJU SKVAMOZNIH ĆELIJSKIH KARCINOMA VRATA I GLAVE

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SAŽETAK

Radiološke metode pružaju pomoć u planiranju lečenja neoplazmi vrata i glave tako što bolje definišu lokalno širenje infiltrativnih tumora i otkrivaju subkliničke adenopatije vrata. Takođe, snimanje igra važnu ulogu u isključivanju i detekciji udaljenih metastaza. Radiološki nalazi su korisni u određivanju optimalne terapije i otkrivanju pacijenata kod kojih postoji veliki rizik od javljanja recidiva i koje zbog toga treba sistematično pratiti. Snimanje se može koristiti za praćenje odgovora tumora, kao i za otkrivanje rekurentne ili perzistentne bolesti pre nego što postane klinički očigledna, što povećava šanse za uspešan ishod.

Ključne reči: **snimanje, praćenje, karcinom skvamoznih ćelija, vrat, glava**