

# PET/MR Imaging in Head and Neck Cancer

## Current Applications and Future Directions

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### KEYWORDS

- PET/MR Imaging • FDG-PET • Oncologic imaging • Melanoma • Squamous cell carcinoma
- Thyroid cancer • Head and neck oncology

### KEY POINTS

- PET/MR imaging is part of routine clinical use at multiple institutions in the United States, Asia, and Europe.
- Clinical PET/MR imaging protocols include whole-body PET/MR imaging, regional PET/MR imaging, and a combination of both.
- Essential to the performance of PET/MR imaging is the execution of a high-quality diagnostic MR imaging in the region of interest.
- Although published research is sparse, it appears that for primary head and neck tumors PET/MR imaging is not inferior to PET/CT and may prove advantageous in certain scenarios.
- PET/MR imaging allows for comprehensive staging of advanced stage melanoma in a single setting, allowing the patient to undergo a single imaging examination.

### INTRODUCTION

Primary malignancies of the head and neck are initially evaluated by physical examination and direct visualization, such as endoscopy.<sup>1-4</sup> Physical examination is often accompanied by computed tomography (CT) in the initial workup of most head and neck cancers. PET/CT is a well-established modality in certain head and neck cancers, particularly for posttreatment

assessment, as well as pretreatment staging. Certain malignancies of the head and neck can benefit from pretreatment MR imaging. For instance, MR imaging may better delineate soft tissue extent of tumors and is superior to CT in sino-nasal or nasopharyngeal tumors.<sup>5,6</sup> MR imaging also has a higher sensitivity and negative predictive value for bone and cartilage invasion.<sup>7,8</sup> MR imaging is also more sensitive for detecting perineural tumor spread. In contrast to sequential

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imaging with PET/CT, the PET and MR imaging sequences in integrated PET/MR imaging systems are acquired simultaneously, which may reduce registration error between images.

Given the complementary nature of these imaging modalities, the emergence of simultaneous PET/MR imaging may play a beneficial role in evaluation of some head and neck cancers. As PET/MR imaging scanners are acquired and used by an increasing number of institutions worldwide along with development of novel radiotracers, the role of PET/MR imaging in head and neck malignancies in both the pretreatment and posttreatment settings will likely expand. The primary aim of this article was to review the current literature pertaining to PET/MR imaging for head and neck cancers and to evaluate potential future directions for research in the field.

### **PROTOCOLS, TECHNICAL CHALLENGES, AND REIMBURSEMENT**

Given the relative paucity of research regarding PET/MR imaging for the evaluation of head and neck cancer, few established dedicated PET/MR imaging protocols have been published.<sup>9–12</sup> The readers are, however, urged to look up a comprehensive and well-written review article that provides a selection of partial-body (skull base to mid-thighs) and whole-body (skull vertex to toes) PET/MR imaging protocols, including one for head and neck cancer.<sup>13</sup> Essential to the value of PET/MR imaging in head and neck cancer is the performance of a high-quality diagnostic MR imaging of the neck. Important MR imaging sequences to include in a protocol include precontrast T1 (preferably without fat suppression), short tau inversion recovery (STIR), diffusion-weighted imaging (DWI), and T2 images, along with multiplanar fat-suppressed T1 postcontrast sequences. Similar to oncologic applications for other regions of the body, the PET and MR imaging portions of the examination provide complementary information. The metabolic evaluation by fluorodeoxyglucose (FDG)-PET plays an important role in staging of nodal and distant metastases for patients with head and neck cancer, whereas MR imaging plays an important role in the precise T staging of the primary tumor and evaluating posttreatment changes from recurrent or residual disease. Thus, a cornerstone of PET/MR imaging evaluation of the head and neck involves execution of a high-quality MR imaging, including both diffusion-weighted and contrast-enhanced images. A significant technical challenge in the performance of both PET/MR imaging and MR

imaging alone of the neck is respiratory motion, which is difficult to correct given the long acquisition times. In the posttreatment setting, PET/MR imaging may be difficult to correctly interpret due to susceptibility artifact from surgical clips following neck dissection. Ultimately, the PET/MR imaging examination should be tailored to answer the specific clinical question and if inappropriate, should not be performed in light of other available options (such as PET/CT).

Billing and reimbursement for PET/MR imaging examinations remains a challenge in current practice, largely due to the relative newness of the hybrid modality. Patients who are being considered for PET/MR imaging are often selected on the basis of needing a dedicated diagnostic MR imaging of the region of interest and comprehensive whole-body staging with PET. Unlike PET/CT, no current procedural terminology (CPT) codes exist to bill for PET/MR imaging examinations. Instead, billing is performed using the appropriate PET-only (78811, 78812, 78813) and MR imaging CPT code(s). Therefore, to be completely reimbursed for a PET/MR imaging examination, it is essential that patients meet criteria for need for both diagnostic MR imaging and PET scans. As PET/MR imaging usage continues to increase in the United States, it is likely that specific CPT codes will be developed for this hybrid modality. These codes could facilitate more widespread patient eligibility and increase utilization of PET/MR imaging for both oncologic and nononcologic indications.

### **CUTANEOUS MELANOMA OF THE HEAD AND NECK**

In clinical practice, PET/CT is often used for the initial staging and follow-up of advanced stages of cutaneous melanoma. For patients at higher risk of metastatic disease (T3 and T4 tumors), sentinel lymph node biopsy and locoregional lymphadenectomy if positive node biopsy is the standard-of-care treatment. Additionally, both pretreatment and posttreatment serum lactate dehydrogenase values play a role in prognosticating successful response to treatment and monitoring for disease recurrence.<sup>14</sup> In patients with positive lymph nodes at the time of surgery, subsequent imaging is needed to evaluate for additional nodal and distant metastases. Several studies have investigated the performance of whole-body MR imaging with PET/CT for melanoma staging.<sup>15–17</sup> When DWI sequences are included in the whole-body MR imaging, sensitivity and specificity are comparable to PET/CT (approximately 82%–84% and 87%–97% for MR

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