ORIGINAL ARTICLE

Is PET superior to MRI in the pretherapeutic evaluation of head and neck squamous cell carcinoma?

Baş-boyun bölgesi yassı hücreli karsinomların tedavi öncesi değerlendirilmesinde PET MRG'den üstün müdür?

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Objectives: This study was designed to compare the effectiveness of positron emission tomography (PET) and magnetic resonance imaging (MRI) in the pretherapeutic staging of squamous cell carcinoma (SCC) of the head and neck.

Patients and Methods: The study included 34 consecutive patients (27 males, 7 females; mean age 61 years; range 42 to 82 years) with SCC of the head and neck. All the patients underwent whole body [18F]fluorodeoxyglucose (FDG)-PET and MRI scans for pretherapeutic evaluation. Diagnoses were confirmed by histopathologic examination of endoscopic biopsy specimens.

Results: The sites of the primary tumors were the oropharynx (n=15, 44%), larynx (n=10, 29%), hypopharynx (n=8, 24%), and nasopharynx (n=1, 3%). Surgery was the treatment of choice in 20 patients (59%), including 23 neck dissections. Fourteen patients (41%) were treated with radiochemotherapy. Both PET and MRI were able to detect the primary tumor in 33 cases (97%). In two patients (6%), PET was able to detect distant metastases in the lung and iliac bone, all of which were confirmed by biopsies. Seven neck specimens (30%) showed lymph node metastasis. Sensitivity and specificity rates for detection of lymph node metastasis were 100% and 87.5% for PET, and 85.7% and 87.5% for MRI, respectively.

Conclusion: Although PET seems to be superior to MRI in detecting nodal disease and distant metastases, it is still early to recommend it as a primary tool for pretherapeutic evaluation of head and neck cancers due to its limited availability and higher cost.

Key Words: Carcinoma, squamous cell/radionuclide imaging; head and neck neoplasms; magnetic resonance imaging; neoplasm staging; positron-emission tomography.

Amaç: Bu çalışmada, yassı hücreli baş-boyun karsinomlarının tedavi öncesi değerlendirilmesinde pozitron emisyon tomografisi (PET) ve manyetik rezonans görüntülemenin (MRG) etkinliğinin karşılaştırılması amaçlandı.

Hastalar ve Yöntemler: Çalışmaya baş-boyun bölgesi yassı hücreli karsinomu olan 34 ardışık hasta (27 erkek, 7 kadın; ort. yaş 61; dağılım 42-82) alındı. Tüm hastalar tedavi öncesinde tüm vücut [18F]florodeoksiglukoz (FDG)-PET ve MRG görüntülemesi ile değerlendirildi. Tüm hastaların tanıları endoskopik biyopsi örneklerinin histopatolojik değerlendirilmesi ile doğrulandı.

Bulgular: Primer tümörlerin yerleşimleri şöyleydi: orofarenks (n=15, %44), larenks (n=10, %29), hipofarenks (n=8, %24), nazofarenks (n=1, %3). Yirmi hastada (%59) cerrahi tedavi uygulandı; bu hastalara 23 boyun diseksiyonu yapıldı. On dört hastada (%41) radyoterapi uygulandı. Her iki görüntüleme yöntemi de 33 hastada (%97) primer tümörü doğru olarak saptayabildi. Ayrıca, PET yardımıyla iki hastada (%6) akciğer ve iliyak kemikte uzak metastazlar saptandı; bunların hepsi biyopsi sonuçlarıyla doğrulandı. Boyun diseksiyonlarının yedisinde (%30) lenf nodu metastazı vardı. Lenf nodu tutulumunun gösterilmesinde duyarlılık ve özgüllük oranları PET için sırasıyla %100 ve %87.5, MRG için %85.7 ve %87.5 bulundu.

Sonuç: Nodal hastalığın ve uzak metastazların saptanmasında PET MRG'den daha üstün görünmesine rağmen, bu yöntemi baş-boyun kanserlerinin tedavi öncesi değerlendirilmesinde esas araç olarak önermek sınırlı kullanımı ve yüksek maliyeti nedeniyle erkendir.

Anahtar Sözcükler: Yası hücreli karsinom/radyonüklid görüntüleme; baş-boyun tümörleri; manyetik rezonans görüntüleme; tümör evrelemesi; pozitron emisyon tomografisi.

Positron emission tomography (PET) has been successfully used to detect a variety of neoplasms, including tumors of the brain,[1,2] lung,[3,4] and breast.[5] It is now well established that cancer cells has a higher uptake of [18F]fluorodeoxyglucose (FDG) in comparison to normal tissue cells.[6] FDG is a glucose analog that is readily transported into tumor cells. There, it is phosphorylated by hexokinase and subsequently trapped, as it is not a substrate for further enzymatic pathways of glucose metabolism. This biologic behavior is used to identify not only the primary tumor, but also to detect possible diseased regional lymph nodes and distant metastases.

Recently, PET with the radionuclide FDG has been used for detection of squamous cell carcinoma (SCC) in the head and neck.[7-10] The pretherapeutic staging of tumors in the head and neck region is important for prognostic assessment and determination of further therapy. Computed tomography (CT) and magnetic resonance imaging (MRI) are the current standard radiologic modalities for pretherapeutic staging. One of the most important prognostic factors is the status of cervical lymph nodes. It is well established that the survival rate for patients with lymph node metastasis is much poorer than those without cervical metastasis.[11] Grandi et al.[12] studied 455 patients with head and neck carcinomas and reported that five-year actuarial survival was 65% for patients without cervical lymph node metastasis (N_0) and 29% for those with cervical metastasis (N_+). The incidence of a synchronous tumor is estimated to be between 0.2% and 9.5%, the most commonly involved organ being the lung.[12]

The purpose of this prospective study was to compare the effectiveness of FDG-PET with MRI in determining the pretherapeutic tumor staging of patients with head and neck SCC.

PATIENTS AND METHODS

Thirty-four consecutive patients (27 males, 7 females; mean age 61 years; range 42 to 82 years) who were seen between April 2004 and February 2005 with suspicion of a SCC were prospectively enrolled. All patients underwent a complete head and neck examination. Preoperatively, PET, MRI, and chest radiographs were obtained in all the patients. The diagnosis was confirmed by panendoscopy and biopsy, and patients were considered for the study after pathologic confirmation of disease.

FDG-PET was performed after a fasting period of at least six hours. The whole body scans were obtained 30 minutes after the injection of FDG. All images were reviewed by the same nuclear medicine expert. No quantitative analysis was performed.

Magnetic resonance imaging criteria of lymph node metastasis were signs of necrosis, blunt margins, and a size greater than 1.0 cm.

RESULTS

All patients were evaluated by MRI, PET and chest radiographs; and subsequently an endoscopic biopsy was obtained. All tumors were diagnosed as SCC.

The most common site of the primary tumor was the oropharynx (n=15, 44%), followed by the larynx (n=10, 29%), and the hypopharynx (n=8, 24%). One patient (3%) had nasopharyngeal carcinoma. Eleven of primary tumors were staged as T_2, followed by eight T_1, and eight T_3 tumors. Seven patients had a T_4 tumor (Table I). The staging of lymph nodes via examination, PET, and MRI was as follows: 15 cases had N_0, 19 patients had N_+ status, of which 14 were N_1 and five were N_2 (Table I). Depending on tumor location, size, and age of the patients, tumor surgery or primary radiochemotherapy were performed. Surgery was the treatment of choice in 20 patients (59%), including 23 neck dissections. Fourteen patients (41%) were treated with radiochemotherapy.

Both PET and MRI were able to detect the primary tumor in 33 cases (97%), whereas they both failed to identify a small T_1 hypopharyngeal tumor. In two patients (6%), PET was able to detect distant metastases in the lung and iliac bone, all of which were confirmed by pathologic biopsy.

All the specimens of neck dissections were examined by a senior pathologist. Seven neck specimens (30%) showed lymph node metastasis. In average,

TABLE I
STAGING AFTER CLINICAL EXAMINATION,
RADIOLOGICAL STUDIES AND PANENDOSCOPY

Staging	T	No. of cases		N	No. of cases	
		n	%		n	%
	T_1	8	24	N_0	15	44
	T_2	11	32	N_1	14	41
	T_3	8	24	N_2	5	15
	T_4	7	21			

TABLE II

COMPARISON OF PET AND MRI IN PREDICTING CERVICAL LYMPH NODE STATUS

	PET (%)	MRI (%)
Specificity	87.5	87.5
Sensitivity	100	85.7
Positive predictive value	77.8	75.0
Negative predictive value	100	93.3

PET: Positron emission tomography; MRI: Magnetic resonance imaging.

the involved lymph nodes were 2.8 cm in size (range 1 to 4 cm). Concerning lymph node staging, PET showed two false positive, no false negative, seven true positive, and 14 true negative results. Magnetic resonance imaging showed two false positive, one false negative, six true positive, and 14 true negative results. Positron emission tomography had a sensitivity of 100% and specificity of 87.5%, and MRI had a sensitivity of 85.7% and specificity of 87.5% for detection of lymph node metastasis (Table II).

Case illustration

A 60-year-old female patient presented with massive dysphagia and weight loss of six-week history. Clinical examination showed a left-sided tumor infiltration of the tongue with invasion on the right side, and bilateral multiple irregular lymph nodes.

Magnetic resonance imaging showed a large oropharyngeal tumor with suspicion of bilateral lymph node metastases (Fig. 1). Positron emission tomography revealed increased FDG uptake in the oropharynx and bilateral cervical lymph nodes and a suspicious lesion in the left iliac crest (Fig. 2). Computed tomography showed osteolytic metastasis in the left iliac crest (Fig. 3). Due to advanced tumor stage with bilateral cervical lymph node metastasis and the presence of bony distant metastasis, we preferred primary radiochemotherapy to surgery.

DISCUSSION

This study summarizes our experience in pretherapeutic evaluation of head and neck SCC comparing FDG-PET and MRI. Nowadays, with the advancement of radiologic studies, it is possible to detect local tumor invasion and possible lymph node involvement.

Currently, CT scan is the gold standard in the evaluation of head and neck tumors. Within the last decades MRI has become more and more important
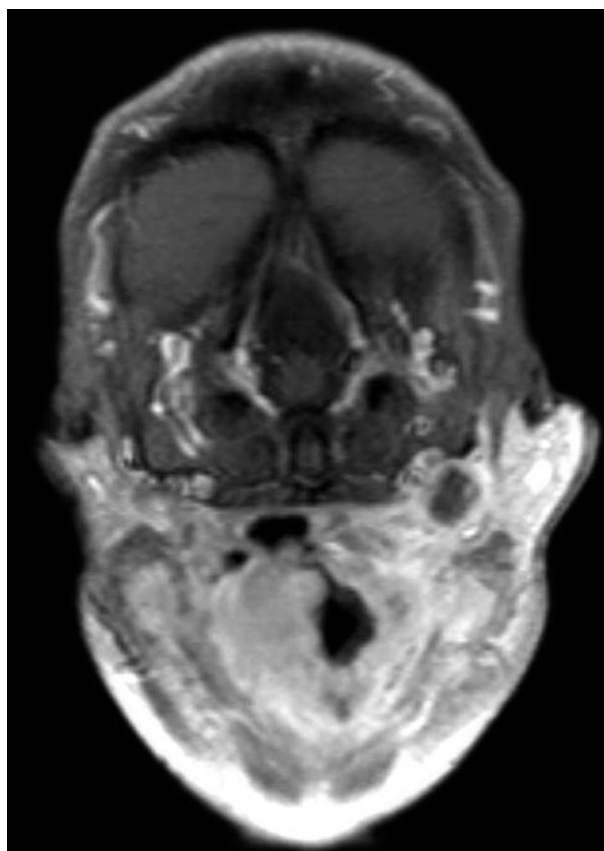

Fig. 1. *Axial plane MRI scan demonstrating a large oropharyngeal tumor formation with suspicion of bilateral lymph node metastasis.*

for head and neck tumors, especially in describing the extent and the localization of the tumor. In this study, FDG-PET results were identical with those of MRI for precise detection of the primary tumor. Both modalities failed to identify a small T_1 hypopharyngeal tumor. While both modalities were able to detect all T_2, and seven of eight T_1 tumors, it turned out that PET could not diagnose tumors smaller than 5 mm due to limited resolution.

Another significant disadvantage of PET is that it is unable to depict anatomic details sufficiently, even though they are mandatory for further planning and performance of surgery. Due to high cost and lack of anatomic details, currently PET cannot be recommended as a routine modality for preoperative staging of head and neck tumors.

In our series PET did not show any advantage for T-staging of the tumor over MRI. Its role is preserved especially for detection of tumor recurrence after surgery and/or radiochemotherapy.[13,14]
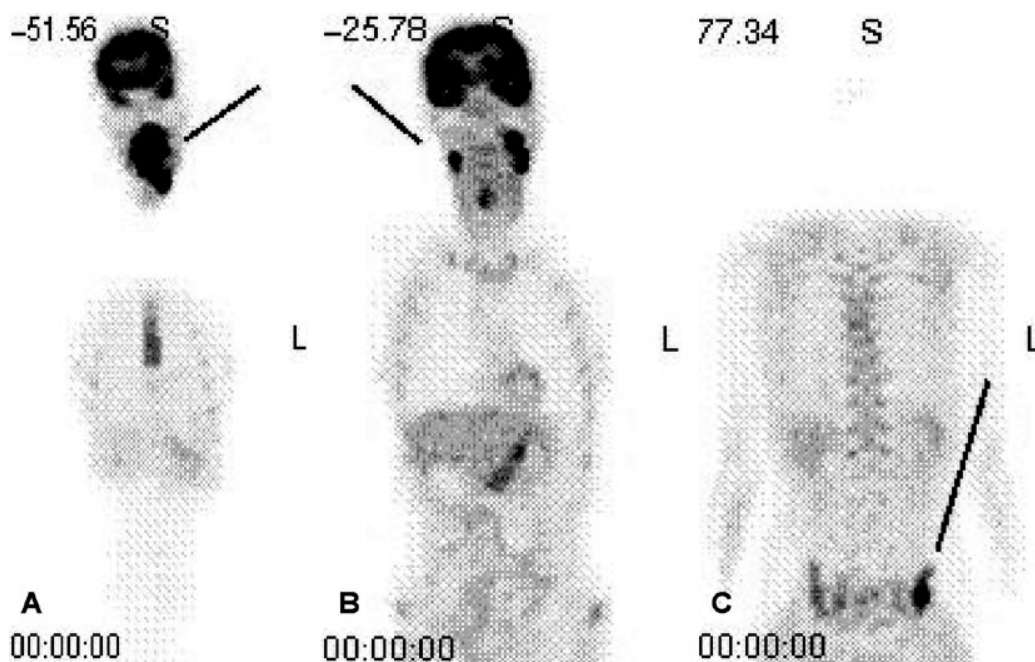
Fig. 2. *Positron emission tomography revealed increased FDG uptake in* **(a)** *the oropharynx and* **(b)** *bilateral cervical lymph nodes, and* **(c)** *a suspicious lesion in the left iliac crest.*

The presence of lymph node metastasis is one of the most important prognostic factors. Until now, many studies have compared the effectiveness of PET and CT/MRI in evaluating the N-status of head and neck tumors.[15-17] Laubenbacher et al.[18] compared the effectiveness of PET and MRI in detecting cervical lymph node metastases in 22 patients with SCC of the head and neck. They reported a sensitivity of 90% and specificity of 96% for PET, and a sensitivity of 78% and specificity of 71% for MRI. They concluded that PET was more accurate than MRI. Wong et al.[19] examined 16 patients and reported a sensitivity of 67% and specificity of 100% for PET, and a sensitivity of 67% and specificity of 25% for CT and/or MRI. In our series both modalities yielded a specificity of 87.5% with respect to detection of lymph node metastasis. Sensitivity of PET, which was 100%, was obviously superior to MRI, whose sensitivity was 85.7%. The accuracy rates for PET and MRI were 91.3% and 87%, respectively. The pathologic analysis showed diseased lymph nodes with a mean diameter of 2.8 cm (range 1 to 4 cm), of which PET was able to detect all.

In general, surgical treatment is reserved for patients with limited locoregional disease. Therefore, the identification of distant disease is critical and may alter the therapeutic strategy. The use of whole-body FDG-PET allows to evaluate the whole body for detection of metastases. Hanasono et al.[20] were able to detect two of four distant metastases in their series using whole-body FDG-PET. Manolidis et al.[21] studied 28 patients with various head and neck cancers and reported a sensitivity of 90% and specificity of 94% for detection of distant disease. They recommended that patients at high risk undergo PET as a screening study.

In our series, PET was able to detect two distant metastases, which were confirmed by biopsy. However, due to the small size of the study group, it is doubtful to make a general recommendation on this issue.
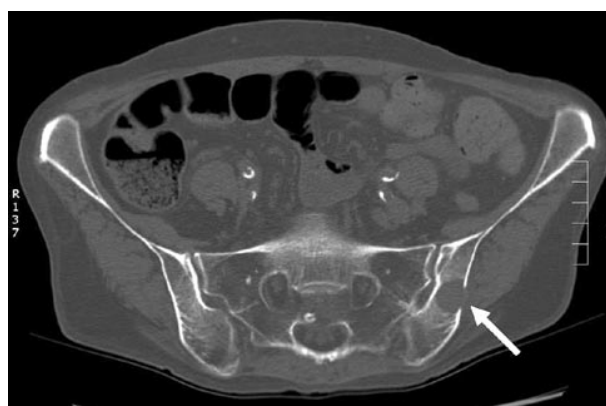

Fig. 3. *Computed tomography scan revealed an osteolytic metastasis in the left iliac crest (arrow).*

The results of this study suggest that PET is not superior to MRI in the pretherapeutic evaluation of head and neck cancers. At least for the time being, because of relatively restricted availability and higher costs compared to MRI, PET is not an ideal measure for pretherapeutic evaluation. However, PET seems to be useful to detect distant metastases; therefore, further investigation is necessary to clarify its indications and utility to assess occult metastases in head and neck cancer patients.

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