Whole-body-MRI with DWIBS for detecting distant metastases in patients with head and neck squamous cell carcinoma: a feasibility study

Poster No.: C-2415
Congress: ECR 2013
Type: Scientific Exhibit
Keywords: Neoplasia, Metastases, Cancer, Screening, Imaging sequences, Diagnostic procedure, PET-CT, MR-Diffusion/Perfusion, Nuclear medicine, Head and neck
DOI: 10.1594/ecr2013/C-2415

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slide shows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Purpose

Patients with head and neck squamous cell carcinoma (HNSCC) are generally not treated with curative intent when distant metastases are detected. Currently $^{18}$F-FDG-PET/CT is the standard screening modality for assessment of distant metastases in patients with HNSCC with predefined high risk factors (Table 1). However, in 19-69% of patients the presence of distant metastases is missed. Therefore, room for improvement remains to avoid futile extensive treatments [1,2].

Whole body magnetic resonance imaging (WB-MRI) has gained considerable interest in the detection of distant metastases. Due to MRI innovations, it has become clinically feasible to perform WB-MRI for detection of distant metastases. High resolution WB-images can be obtained with examination times below one hour [3,4]. In addition to conventional WB-MRI, which makes use of routine T1- and T2-weighted imaging, diffusion-weighted whole-body imaging with background body signal suppression (DWIBS) has shown potential for a more functional approach to WB-MRI [5-8]. Diffusion-weighted imaging is based on cellular density and motion, by means of quantifying this motion within a certain area [6]. Previous studies have shown promising results in the addition of DWIBS to WB-MRI protocols [9-11], providing high sensitivity compared to $^{18}$F-FDG-PET/CT for the detection of metastatic disease.

The purpose of our study was to assess the feasibility of a tailor-made WB-MRI protocol including DWIBS, for the work-up of patients with HNSCC with risk factors for the development of distant metastases.
Risk factors for the occurrence of distant metastases

Low jugular nodal metastases

Nodal metastases with a diameter of at least 6 cm

Clinical presence of at least 3 nodal metastases

Bilateral nodal metastases

Second primary tumor or locoregional relapse

Table 1

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Methods and Materials

For this single-centre prospective pilot study we included 33 consecutive patients (26 male, 7 female; mean age 63 ± 7.9 years; range: 48-79 years). All patients were planned for extensive treatment with curative intent and had at least one high risk factor for the development of distant metastases (Table 1) [1]. Histopathological specimens and/or minimal six months of follow-up served as reference standards. Three modality imaging was performed: WB-MRI, $^{18}$F-FDG-PET/CT and contrast-enhanced chest-CT (up to the adrenals).

Whole-body MRI

A tailor-made 60-min MRI protocol was scanned at 1.5T, containing STIR, T1 and DWIBS (b=0/1000) in the coronal plane, and HASTE-T2 and contrast-enhanced-T1 in the axial plane (Fig. 1). Images were analysed for abnormalities by two independent observers with 4 and 2 years experience in WB-MRI. Image quality (1= inadequate, 2= adequate, 3= good and 4= excellent) and artefacts (0= none, 1= irrelevant, 2= diagnostically relevant, 3= marked) were rated on four-point scales. Interobserver variability was assessed using Cohen's kappa. Analysis times were recorded in two phases: in the first phase only conventional sequences were evaluated, in the second phase DWIBS was added and the image analysis was completed. Paired sample t-tests were used to compare the examination times of both observers. The readers were asked to mark the sequences of their preference for the final diagnosis, and to indicate when DWIBS aided in the final diagnosis in cases of doubt.

Whole-body MRI findings were compared to $^{18}$F-FDG-PET/CT and diagnostic chest-CT.

$^{18}$F-FDG-PET/CT and chest-CT

In 32 patients $^{18}$F-FDG-PET/CT was performed on a 64-slice PET/CT-scanner and in one patient on a 16-slice PET-CT scanner. Images were analyzed for abnormalities by two independent observers with >10 and 4 years of experience. Interobserver variability was assessed using Cohen's kappa. Diagnostic chest-CT was performed in the early arterial phase after intravenous contrast administration in 32 patients on a 64-slice CT-scanner and analyzed by one observer with 7 years of experience. In one patient only low-dose CT was performed.
Risk factors for the occurrence of distant metastases

Low jugular nodal metastases

Nodal metastases with a diameter of at least 6 cm

Clinical presence of at least 3 nodal metastases

Bilateral nodal metastases

Second primary tumor or locoregional relapse

Table 1

Fig. 1: Tailor-made whole-body MR protocol as performed at our institution. Abbreviations: TIM = total imaging matrix, STIR = short-TI inversion recovery, SE = spin-echo, HASTE = half-Fourier single-shot turbo spin-echo sequence, GRE = gradient echo, VIBE = volumetric interpolated breath-hold examination, CE = contrast-enhanced.

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Results

Imaging findings

According to the reference standards, 3 patients were diagnosed with distant metastases (n=1) or secondary primary tumors (SPT, n=2).

The three modalities yielded the following findings:

- One lung metastasis was detected with all three modalities (Fig. 2). On WB-MRI the lesion was detected mainly due to the diffusion restriction on DWIBS.
- In 2 patients, WB-MRI detected SPTs (neuroendocrine liver metastases (Fig. 3) and renal cell carcinoma (RCC) (Fig. 4)). Both were not detected on \(^{18}\)F-FDG-PET/CT. On diagnostic chest-CT the RCC was detected and graded as a potentially malignant lesion, the neuroendocrine liver metastases were not detected.
- On MRI an adrenal lesion was correctly qualified as benign, whereas diagnostic chest-CT was equivocal. The lesion did not show \(^{18}\)F-FDG uptake on \(^{18}\)F-FDG-PET/CT (Fig 5).
- One vertebral bone lesion was interpreted as suspect on MRI, but was not detected on \(^{18}\)F-FDG-PET/CT. On chest-CT the lesion was detected only after comparison with MR-findings. Therefore this lesion is regarded as undetected on chest-CT in further data-analysis. After biopsy this lesion proved to be false-positive, no abnormalities were seen on histopathology (Fig. 6).

WB-MRI feasibility

- For WB-MRI interobserver variability was \(\kappa=0.84\) and agreement was 98.9%.
  For \(^{18}\)F-FDG-PET/CT this was \(\kappa=0\) (because one reader did not detect the distant metastasis nor both second primary tumors) with an agreement of 97.7%.
- Image quality of WB-MRI was rated as 3.3-3.9, assessment of artefacts as 1.0-1.7.
- Mean examination times differed significantly between the two observers; being mean 3 and 12 minutes (p<0.001) before the addition of DWIBS and 1 and 4 minutes (p<0.001) after the addition of DWIBS, respectively.
- According to the observers the most useful imaging sequences for diagnoses consisted of DWIBS and HASTE-T2.
- In 2 patients, DWIBS aided in making the correct final diagnosis.
Fig. 2: Focal pulmonary lesion of 8mm (arrows) in the apex of the left lower lobe in a 62-year old male. The lesion shows high signal intensity on coronal STIR (a) and moderate signal intensity coronal T1 (b) and axial HASTE-T2 (d). The lesion is suspected to be malignant, mainly due to diffusion-restriction on the coronal DWIBS (c). The lesion demonstrates 18F-FDG uptake on the fused axial 18F-FDG-PET/CT image (e). On axial diagnostic chest-CT (f) a solitary non-calcified nodule is seen. On all three modalities this lesion is suspected to be malignant. Biopsy confirmed the lesion to be squamous cell carcinoma.

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Fig. 3: Focal liver lesion (arrows) in a 68-year old male (multiple other lesions with identical characteristics not shown). Coronal STIR (a) and axial HASTE-T2 (d) both display a 30mm lesion with high signal intensity. The lesion demonstrates low signal intensity on coronal T1 (b) and shows diffusion-restriction on coronal DWIBS (c). Based on these findings this lesion is suspicious of malignancy, with neuroendocrine liver metastases as first differential option. Axial fused 18F-FDG-PET/CT (e) and axial diagnostic chest-CT (f) show no abnormalities. Biopsy confirmed the lesion to be a neuroendocrine liver metastasis.

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Fig. 4: Renal lesion of 8cm (arrows) in a 78-year old male with strongly heterogeneous signal on coronal STIR (a), coronal DWIBS (c) and axial HASTE-T2 (d). Coronal T1 (b) shows a low signal intensity mass. Therefore this lesion is interpreted as malignant. On axial fused 18F-FDG-PET/CT the lesion shows moderate 18F-FDG-uptake and was interpreted as a (benign) cyst (*), whereas the lesion is classified as malignant on axial diagnostic chest-CT (f). After resection the lesion proved to be renal cell carcinoma.
Fig. 5: Adrenal lesion of 20mm (arrows) in a 67-year old female. Other findings include a simple and hemorrhagic left renal cyst (*) and cholelithiasis (arrowheads). On coronal STIR (a) and coronal T1 (b) the adrenal lesion is hard to delineate and remains equivocal. The clear drop in signal intensity between the in- (d) and opposed-phase axial GRE-T1 (e) is indicative of the presence of a large amount of intratumoral fat, and hence benign adrenal adenoma. Additionally there is no significant diffusion-restriction on coronal DWIBS (c). Axial fused 18F-FDG-PET/CT (f) shows low 18F-FDG-uptake and on axial diagnostic chest-CT (g) the lesion remains equivocal. At follow up the lesion did not show progression.

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Fig. 6: Focal cervical bone lesion (arrows) at C7 in a 69-year old female. The 12mm lesion shows focal increased signal intensity on coronal STIR (a), isointense signal on coronal T1 (b), slightly abnormal signal intensity on coronal DWIBS (c) and hyperintensity on axial T2 (d). Based on MR findings the lesion is suspected to be malignant. The lesion is not observed on axial fused 18F-FDG-PET/CT (e). On axial diagnostic chest-CT (f) the lesion was only detected after comparison with MR-findings. After biopsy the lesion proved to be false-positive, no abnormalities were seen on histopathology.

© Radiology, VU Medical Center Amsterdam - Amsterdam/NL
Conclusion

WB-MRI with DWIBS is feasible for the work-up of HNSCC patients. Our pilot study suggests that WB-MRI allows for improved detection of second primary tumors and equal detection of distant metastases compared to $^{18}$F-FDG-PET/CT. The use of coronal images requires some extra training as most radiologists are more familiar with axial images. We believe that there is a learning curve in the evaluation of WB-MRI including DWIBS. In addition, experience with reading WB-MRI is needed to deal with an increased amount of incidental findings.
References


Personal Information

Daniel P Noij, BSc¹, Els J Boerhout, MD¹, Indra C Pieters-van den Bos, MD, PhD¹, Emile F Comans MD, PhD¹, Daniela Oprea-Lager, MD¹, Rinze Reinhard, MD¹, Remco de Bree, MD, PhD², Jonas A Castelijns, MD, PhD¹

Departments of Radiology, Nuclear Medicine & PET-research¹; and Otolaryngology/Head and Neck Surgery², VU University Medical Center, Amsterdam, The Netherlands