Percutaneous MR-guided high-dose-rate brachytherapy of liver metastasis

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Purpose

The purpose of this study was to evaluate the feasibility, safety and effectiveness of MR-guided percutaneous applicator placement for interstitial high-dose-rate (HDR) brachytherapy of liver metastasis.

Introduction

A number of research groups have performed percutaneous applicator placement for interstitial HDR using ultrasonography or computed tomography (CT) to target tumor tissue. To our knowledge, the excellent soft tissue contrast, and multiplanar capabilities of MRI had not been used yet for image-guided brachytherapy of liver metastasis.

Methods

Four patients with unresectable liver metastases from colorectal cancer were treated in 6 sessions, using an open MR system (0.2-Tesla, Magentom Open Viva, Siemens) installed in an operating room environment with MR-compatible monitoring of vital parameters and anesthesia equipment.

Patients were placed within the MR-scanner in a supine position, a multipurpose-surface coil (35 cm or 45-cm diameter) mounted around the upper abdomen. Hepatospecific contrast agent (50 ml Teslascan, Nycomed, Oslo, Norway) was applied i.v. and T1- and T2-weighted (fast)spin-echo images were acquired prior to MR-guided biopsy to localize liver metastasis.

Tissue samples were obtained prior to irradiation by a MR compatible biopsy system (16 - 18G) to confirm malignant disease. Based on the associated susceptibility artifacts the position of the brachytherapy-applicator was identified on rapid gradient-echo images. Following MR-guided biopsy, up to four MR-compatible brachytherapy-applicators (length 20 - 24 cm, diameter 14 G) suitable to be attached to a high-dose-rate afterloader (MicroSelectron, Nucletron) were placed within the metastasis (Figure 1).

The appropriate position of the brachytherapy-applicators was confirmed by T1- and T2-weighted (fast)spin-echo images. Treatment planning was carried out on a Nucletron-PLATO-system, whereas the position of brachytherapy-applicators on MRI was correlated to their position visualized on orthogonal abdominal plane with small landmarks attached to the skin. Metastases were treated by a high-intensity Iridium-192 source (5-10 Ci; 185-370 GBq) using an afterloading technique.

Results

The open MR-system allowed more or less access to the patient while providing near real-time images or image updates. A pathologic diagnosis was obtained in all biopsy specimens prior to brachytherapy.

Both local anesthesia and sedation (n = 1) or general anesthesia (n = 5) was applied. To target and to biopsy a lesion took 60 ± 12 minutes, to place the brachytherapy applicators 34.5 ± 14 minutes. For treatment planning another 120 minutes were needed, whereas the duration of radiation was 21.8 ± 8 minutes.

Depending on the tumor volume (mean 81 ± 61 ml) the dose administered to the tumor periphery was up to 20 Gy. All patients tolerated the procedure well without major complications. Two patients had to be retreated due to the large diameter of metastasis (> 8 cm) or due to a second distant metastasis.

In all patients tumor necrosis was confirmed on MR-imaging performed at 1 week, 1-, 3- and 6 months following ablation, additionally in 2 patients by liver biopsy of a previously treated lesion.

Discussion

We have demonstrated that MR-guided biopsy of liver lesions and MR-guided brachytherapy is technically feasible and safe. MR guidance was particularly useful for needle placement within lesions in the liver dome or to identify lesions not well depicted by other imaging modalities. However, due to preparatory scans and sometimes poor lesion-to-liver contrast obtained on a low-field magnet, targeting and MR guided biopsy can be time-consuming. In particular patient transfer and treatment planning may cause additional delay.

Nevertheless, MR-guided percutaneous HDR brachytherapy appears to be safe with the potential to sufficiently ablate metastatic liver tumors.

References


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