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Case Report

CT-guided navigated microwave ablation (MWA) of an unfavorable located breast cancer metastasis in liver segment I

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ABSTRACT

For percutaneous minimally-invasive local ablation therapies of malignant lesions within the liver computed tomography (CT) fluoroscopy or ultrasound (US) can be applied for the positioning of ablation probes. However, lesions in liver segment I and in the upper part of liver segment VIII are difficult to reach with CT fluoroscopy and US guidance even for experienced interventionalists as steep and transcostal access paths may be needed. In addition, there is always the risk to lacerate crucial vessels near the liver hilus. We report on the use of a CT-based stereotactic navigation system (CAS-One, CAScination AG, Bern, Switzerland) for the precise positioning of the ablation probe to perform a percutaneous stereotactic image-guided microwave ablation of a breast cancer liver metastasis in liver segment I that was unreachable with conventional CT or US guidance. Based on the initial planning scan and image-to-patient registration a precise positioning of the probe was possible sparing vital structures like the directly adjacent vulnerable vessels. The ablation was performed without complications fully covering the metastatic lesion with the ablation zone. To this day, there was no recurring tumor 18 months after the intervention.

Introduction

The liver is a common site for metastatic disease, especially from colorectal cancer [1]. Today surgical approaches, eg,

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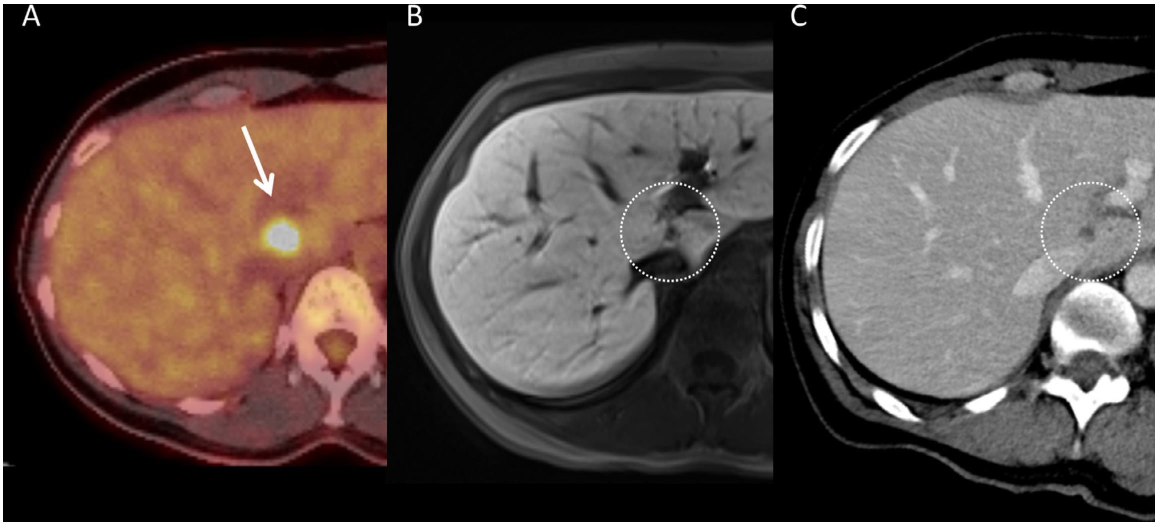

Fig. 1 – FDG PET-CT (A, arrow), MRI in hepatobilliary phase (using Gadoxetate (Primovist); B, dotted circle) and contrast enhanced CT in venous phase (C, dotted circle) show the metastasis in the caudate lobe, directly adjunct to the left portal vein and the inferior vena cava.

resection or liver transplantation are pursued, however, only a minority fits the necessary requirements [2]. To overcome this, various interventional treatment options have become available. For local thermal ablation, radiofrequency ablation (RFA) and more recently microwave ablation (MWA) have been developed. Other methods for a local therapy are laser-induced interstitial thermotherapy, cryotherapy, computed tomography guided interstitial high-dose rate brachytherapy, or irreversible electroporation [3]. In our institution MWA is the most commonly used procedure and we report the successful treatment of a breast carcinoma liver metastasis in a very unfavorable location in liver segment I using CT-based stereotactic image-guided microwave ablation (SIMWA).

Case report

The patient presented in this report was part of a prospective clinical study with the aim to evaluate short-term clinical outcome of patients undergoing percutaneous SIMWA for liver metastases (excluding colorectal metastases). The study was approved by the local ethical committee. In May 2016 a 52-year-old female patient with an abnormal finding in her right breast on the screening mammogram presented at our institution. Biopsy revealed an invasive ductal carcinoma (estrogen receptor 60%, progesterone receptor 5%-20%, Ki67 25%, HER positive). The subsequent FDG PET-CT showed an active lesion in the caudate lobe of the liver. The final tumor stage was T2, N0, M1. Chemotherapy with Trastuzumab (Herceptin), Pertuzumab (Perjeta), and Docetaxel (Taxotere) with a total of 5 cycles (dose reduction of Docetaxel due to major side effects), followed by systemic therapy with Trastuzumab and Pertuzumab was admitted. The FDG PET-CT, 4 months after starting the chemotherapy showed decreased activity of the liver metastases (Fig. 1A). Surgery of the right breast (segmental resection, negative tumor margins) was followed by adjuvant high dose brachytherapy (cumulative dose 32 Gray (Gy)) 1 month later.

Due to the unfavorable location in the caudate lobe (Fig. 1) with a distance of only 4 mm to the inferior cava vein and a distance of 3 mm to the left portal vein surgery would be invasive and extensive. The interdisciplinary tumor board therefore recommended a CT-based SIMWA for therapy considering the oncological circumstances of the patient.

As the lesion was located just between the left portal vein and the inferior vena cava, it would have been very difficult even for an experienced interventionalist to position the ablation probe precisely within the lesion while not risking to injure the vessels and otherwise to ensure a full therapeutic coverage of the lesion. Therefore, a navigation system (CAS-One, CAScination AG, Bern, Switzerland) was used to perform the procedure. This system allows to import the imaging data of an initial contrast enhanced CT planning scan acquired while the patient is under general anesthesia using jet ventilation [4]. Six markers are attached to the skin of the patient before the planning scan that allow a real-time image-to-patient registration. A 3D planning of the precise probe access path is based on the CT data. Real-time tracking of both the patient position and of the aiming enables the interventionalist to insert die ablation probe in just the right angle and the exact planned depth to reach the center of the planned ablation zone.

The initial contrast enhanced CT planning scan showed the known metastasis with a diameter of 8 mm in liver segment I (Fig. 2A). The ablation probe (Accu2ioTMA, Angiodynamics, NY) was introduced via a transcostal approach, penetrating a distance of 11 cm through the liver parenchyma. A reformatted, preinterventional control scan showed the precise probe position in the middle of the lesion. The planning algorithm within the navigation device was used to define the expected ablation area with a sufficient safety margin while sparing sensible vessel structures (Fig. 2A). Intensity and duration of required energy were calculated

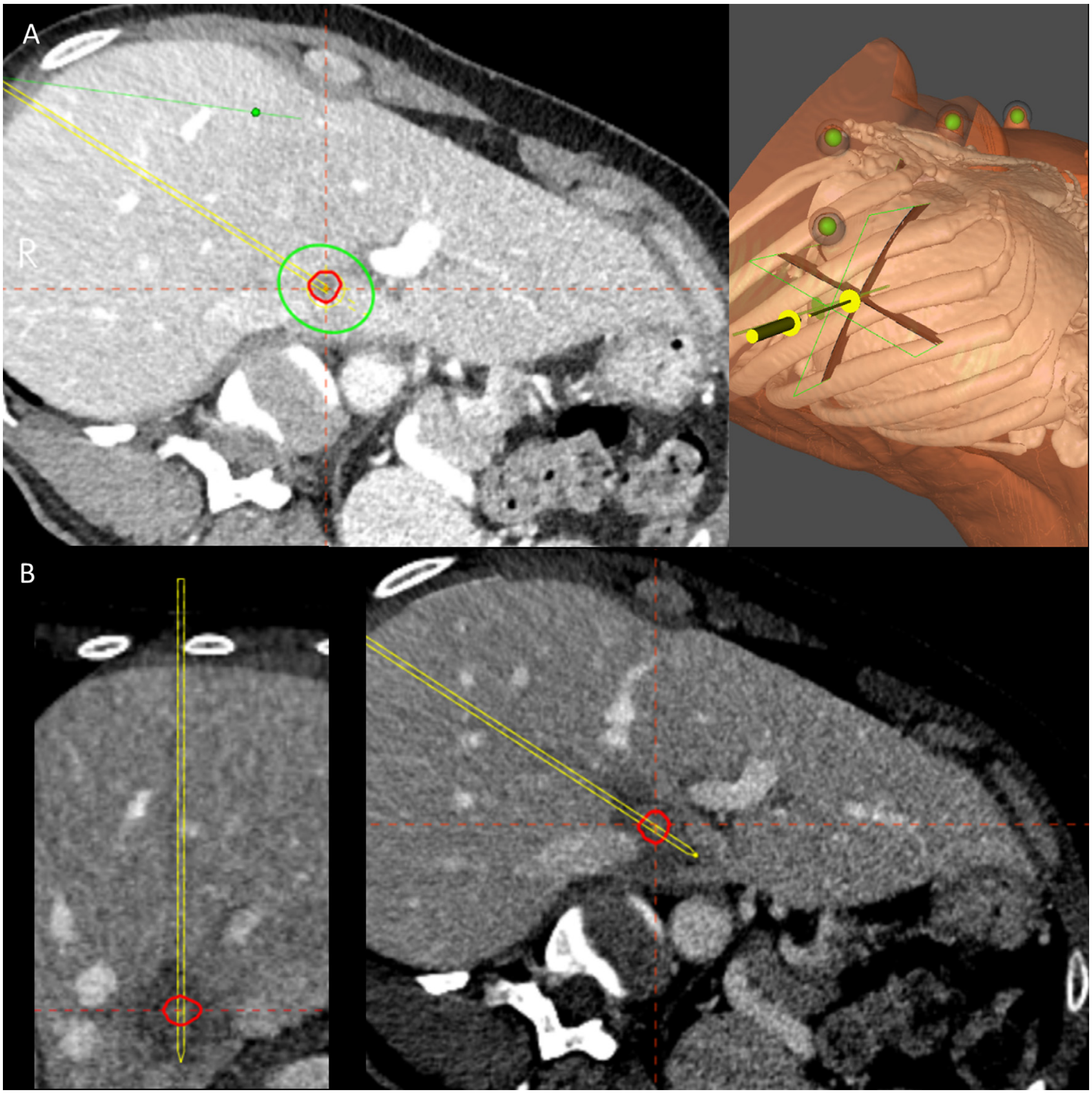

Fig. 2 – Prior MWA 3D planning of the ablation area (A) allows the precise definition of a safety margin while sparing sensible vessel structures. Post interventional control (B) shows near perfect match between planned and treated tissue.

and microwave ablation was applied as planned with a power of 100W for 2 minutes. Immediate postinterventional contrast enhanced control scan (Fig. 2B) revealed an ablation area of 30 × 16 mm, exactly as planned and fully covering the initial lesion also providing an adequate safety margin. The inferior vena cava and the left portal vein were not affected.

The 3- and 6-month follow-up Gadoxetate enhanced MRI showed expected postinterventional change with diminished intracellular uptake of the contrast agent (Fig. 3B) without any trace of residual tumor also considering MR sequences of contrast dynamic and diffusion-weighted imaging.

Systemic chemotherapy with Trastuzumab and Pertuzumab ended in April 2017 the patient is under single therapy with Trastuzumab until today.

Discussion

Effectiveness of local ablation procedures depends on physical properties of the applied technique and on precise positioning of the probe within the lesion. Temperature of the target tissue is critical, which is influenced by tissue density, thermal conductivity, and loss of temperature due to tissue perfusion (so called heat-sink-effect). Heat is transmitted via a probe which can be placed percutanously or laparoscopically. For successful ablation the temperature should be homogenously raised to 50°C-60°C [5]. In RFA heat is generated by alternating current in the RF range of 200 Mhz-3 Ghz. Only few millimeters of tissue surrounding the tumor undergo active heating, most of the tissue is heated by conduction [6].

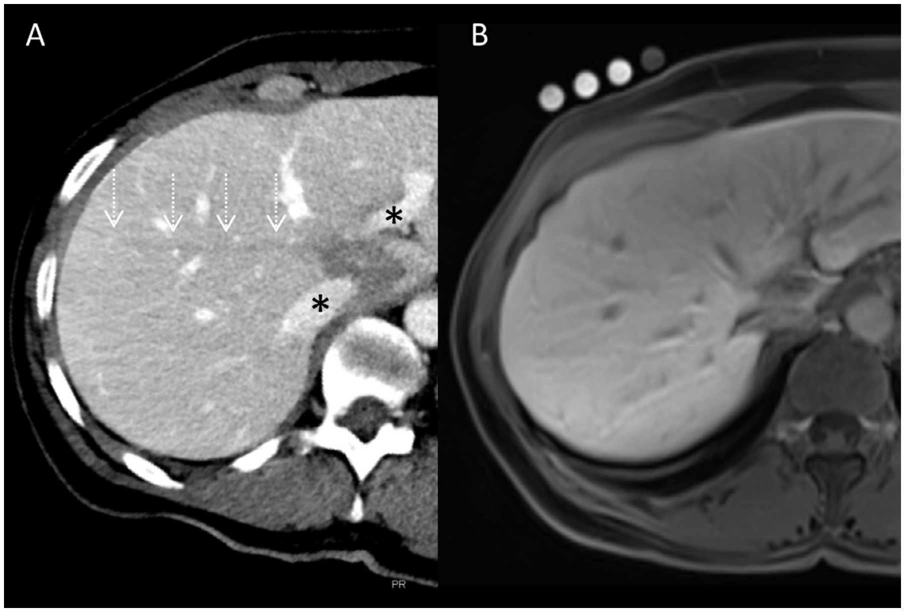

Fig. 3 – In the CT control scan after the ablation the lesion is fully covered leaving the adjacent left portal vein branch and a major liver vein unimpaired (A, asterisks). The access route via liver parenchyma is routinely treated with small energies during needle retraction to prevent spreading tumor cells. The coagulated access route is nicely seen in the control scan after the ablation (A, dotted arrows). Six-month follow-up MRA in hepatobiliary phase using Gadoxetate shows a slightly retracted scar in the caudate lobe.

In our case, MWA is favorable because of the superior physical properties. MWA generates radiation between 900 Mhz and 2,4 Ghz [7] and in comparison to RFA, it is not susceptible to increasing impedance from ablated tissue and is not completely dependent on hydrated tissue [6]. In MWA more direct energy deposition is possible resulting in more uniform heating [8]. Furthermore, due to the close proximity to the vessels (portal vein and hepatic vein) a significant heat-sink effect was to expect. In MWA this effect is less evident and the proximity to large vessels is a contraindication for RFA [9]. MWA also seems to be more effective in preventing long term progression and local recurrences [10].

The use of the navigation system allowed to define a safe access route and a precise positioning of the tip of the probe as well as a predefinition of the expected areal of ablation depending on the applied energy and duration of ablation time. A contrast-enhanced control scan after the ablation procedure can be fused with the preinterventional imaging allowing a precise control of the ablation margins. Extensive surgery could be avoided, post-treatment complication rates are expected to be low [11].

Percutaneous ablation techniques are a major advance in the treatment of liver tumors and can represent an excellent alternative treatment strategy in patients that are poor surgical candidates because of comorbidity or the underlying liver disease. Using a CT-based stereotactic navigation system seems technically feasible and safe and might offer minimal-invasive treatment options for conventionally unreachable tumor locations adjacent to sensible intra- and extrahepatic structures.

Statements

All authors declare that they have no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2018.10.010.

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