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Multipolar radiofrequency ablation for colorectal liver metastases close to major hepatic vessels

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ABSTRACT

Background: Resection of colorectal liver metastases (CRLM) is often hindered by their location close to the major hepatic vessels. So far, radiofrequency ablation for perivascular tumours was thought to be ineffective and unsafe due to either the heat sink effect or vascular thrombosis. The aim of this study was to examine whether RFA using multipolar probes could be a safe and effective option for CRLM adjacent to major hepatic vessels.
Methods: Patients were treated with multipolar RFA during an open procedure using 3 simultaneously placed electrodes. In 52 consecutive patients with CRLM, 144 tumours were ablated with RFA. In 16 out of 52 (31%) patients, metastases were abutting major hepatic vessels. We examined whether perivascular location was a risk factor for local tumour progression. The relation between perivascular location and time to local tumour progression and recurrence free survival was assessed using cox-regression analysis.
Results: All patients were followed for at least 3 years after RFA unless they deceased before this time. Local tumour progression following RFA occurred in 17 out of 144 tumours (12%), of which 4 out of 21 were perivascular tumours. Tumour size was the only risk factor for local tumour progression in this study. Proximity to large vessels was neither a risk factor for local local tumour progression, nor for time to local tumour progression or recurrence free survival.
Discussion: This study indicates that patients with CRLM abutting any of the large hepatic vessels can be safe and effectively treated with RFA when using a multipolar system.

Introduction

Colorectal liver metastases (CRLM) close to major hepatic vessels (≥4 mm in diameter) are often seen as a contraindication for liver resection due to technical difficulties, limited postsurgical remnant liver and a high complication rate.[1] In these patients, radiofrequency ablation (RFA) could be a valid option by selectively ablating the tumour, while sparing normal adjacent vasculature and liver tissue. However, the safety and effectiveness of RFA adjacent to major hepatic vessels has been debated (Figs. 1–2).

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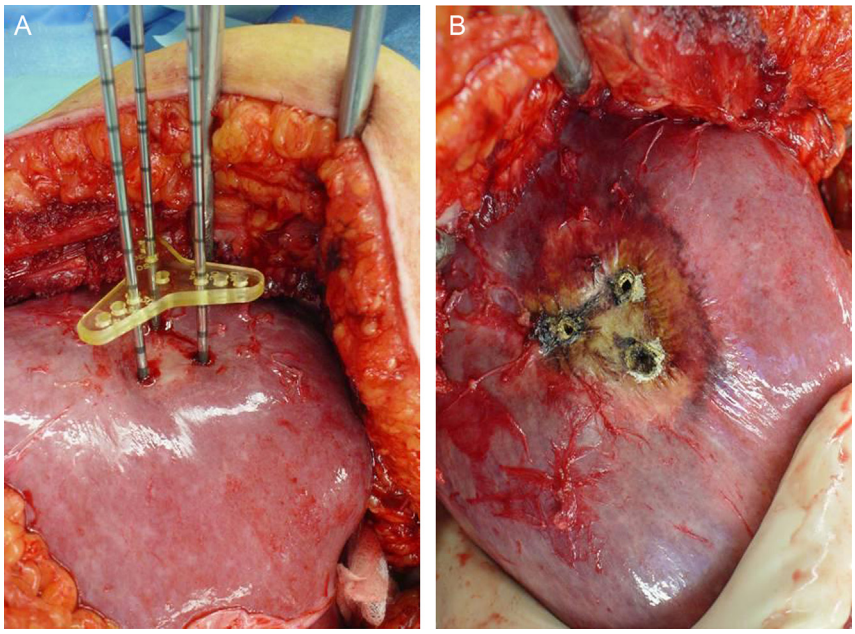

Fig. 1 – A: Configuration of multipolar RFA electrodes. B: Post RFA effect after treatment with multipolar RFA.

The conductive heat loss caused by the proximity of major vessels, known as the heat-sink effect could prevent sufficient heat build-up in areas near the vessel leading to incomplete tumour destruction.[2–5] The heat-sink effect has been reported in the majority of cases of RFA near vessels measuring 4 mm or larger in porcine livers.[6] Indeed, RFA of CRLM adjacent to major hepatic vessels was found to be associated with a significantly higher incidence of local tumour progression (defined as the outgrowth of residual cells due to incomplete ablation) in pre-clinical and clinical studies.[2–5]

Local tumour progression diminishes chances of cure as retreatment is often not possible.[7] Most RFA systems use monopolar electrodes and a generator in which a closed electric circuit is formed by the patient, the RFA generator and electrodes. In monopolar RFA systems, heat is produced by only one heat source. Heat transfer in the liver relies on conduction, which is affected by the perfusion of the tumour, amount of tumour necrosis and the conditions and perfusion of surrounding liver parenchyma.

The next generation RFA systems use bipolar electrodes that are less susceptible to the "heat sink effect". These electrodes are typically placed in a triangle or square formation at the edges of the tumour. Since the electrical current is moving from one electrode to the other, heat is trapped in between. With the multipolar system used in this study, the impedance of the tissue is constantly monitored and the power is automatically adjusted to the impedance in order to prevent early tissue dehydration and thereby loss of heat conduction.[8–10] Moreover, more electrodes (up to 6) can be placed at the same time within one application, thereby increasing the size of the ablation zone and limiting the chance of tumour spread through movement of the electrodes.

The aim of this study was to examine whether patients with CRLM adjacent to any of the major hepatic vessels can

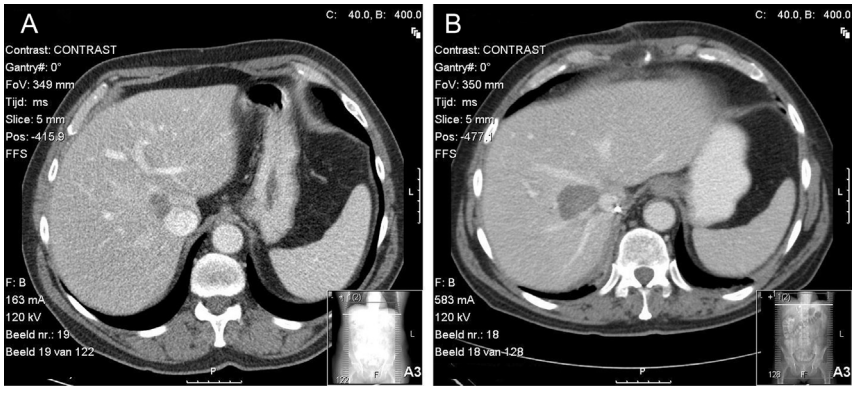

Fig. 2 – A: Tumour adjacent to caval vein and between middle and right hepatic vein. B: Ablation area of tumour adjacent to caval vein and between middle and right hepatic vein.