Abstract  Background: Percutaneous ethanol injection (PEI) and radio-frequency (RF) ablation are possible palliative treatment modalities for patients with non-resectable liver metastases of colorectal carcinomas. The different techniques are explained and reviewed.  Results: PEI did not show promising results for the treatment of liver metastases. RF results were more encouraging; some studies showed improved mean survival times for patients when a complete necrosis of the metastases could be achieved. The maximum diameter of the necrotic area possible in a single session is about 5 cm.  Conclusion: PEI and RF are palliative last-line treatment strategies for patients with non-resectable liver metastases and should only be applied if chemotherapy is not sufficient or not possible. The long-term efficacy of RF ablation in this group of patients has to be evaluated.

Key words  Liver tumours · Ultrasound · PEI · Radio-frequency ablation · Review

Introduction

Interventional therapy for liver tumours can be achieved in several ways. Further on in this issue, therapy modalities such as chemoembolisation, cryosurgery and interstitial laser therapy have been described. This study reports about two other interventional treatment modalities that are a possible palliative way to treat patients with non-resectable liver metastases of colorectal cancer. It is very important to distinguish between patients suffering from a tumour originating from the liver itself and patients with liver metastases of tumours originating outside the liver.

In patients with hepatocellular carcinoma (HCC), the treatment modalities described here were used more and more often during the last years and proved to be very efficient. For example, for a selected group of patients suffering from HCC, percutaneous ethanol injection (PEI) showed equivalent long-term results in survival to those of surgical resection [1, 2, 3].

Further on, it must be emphasised that interventional treatment strategies such as PEI or radio-frequency ablation (RF) for liver metastases of colorectal carcinomas are currently still in an experimental phase and cannot be recommended as first-line therapies. Before a patient can or should be treated using these modalities, all other established possibilities to treat the liver metastases should have been applied. Only when these established protocols (resection, chemotherapy in established first or second line protocols) have been applied or are impossible due to technical reasons, contraindications or side effects, interventional treatment strategies can play a role. To the author’s view, it is possible that RF can become an additional therapeutic strategy in combination with chemotherapy protocols for tumour mass reduction, but this assumption has to be proved in randomised prospective studies.

Techniques

PEI therapy

PEI therapy is based on the fact that absolute alcohol (98% ethanol) induces cell necrosis. Visualisation of the
tumour or the tumours and guiding of the alcohol injection needle can be achieved with both radiologic methods or ultrasound (US). US provides a real-time control of the alcohol injection therapy and, if the tumour can be visualised this way, this is the imaging method of choice to control the treatment. Under local anaesthesia, the needle is forwarded into the tumour. We use needles (21 G) with multiple side holes at the tip through which the ethanol is injected. Real-time imaging provides very good control of the distribution of ethanol in the tumour area, but of course the ethanol injected spreads along the way with the lowest resistance. In HCCs, where the tumour nodules consist of softer tissue than the surrounding “hard” liver cirrhosis, the ethanol remains more within the tumour, resulting in a higher concentration than is possible in liver metastases. To achieve better results, the injection therapy must be performed in multiple sessions. This means, an amount of alcohol, depending on the size of the tumour, has to be injected every 2–3 days 5–15(!) times. The ethanol volume injected can vary between 2 ml and 20 ml per session and tumour. This results in a duration of treatment lasting from 1 week to 3 weeks for one liver tumour, depending on the tumour size. During each session, the administration of ethanol in the tumour area can be visualised by US, the volume of ethanol injected can vary between 2 ml and 20 ml per session and tumour. Real-time imaging provides very good control of the distribution of ethanol in the tumour area, but of course the ethanol injected spreads along the way with the lowest resistance. In HCCs, where the tumour nodules consist of softer tissue than the surrounding “hard” liver cirrhosis, the ethanol remains more within the tumour, resulting in a higher concentration than is possible in liver metastases. To achieve better results, the injection therapy must be performed in multiple sessions. This means, an amount of alcohol, depending on the size of the tumour, has to be injected every 2–3 days 5–15(!) times. The ethanol volume injected can vary between 2 ml and 20 ml per session and tumour. This results in a duration of treatment lasting from 1 week to 3 weeks for one liver tumour, depending on the tumour size. During each session, the administration of ethanol in the tumour area can be visualised by US, the volume of ethanol injected always depends on the imaging results of the ethanol distribution in the tumour area, which becomes visible as a hypechoic area during injection (Fig. 1). Using real-time image control, draining of ethanol into large vessels can be avoided by replacing the needle tip. The volume of ethanol injected can be limited by the localisation of the tumour nodule(s). When pure ethanol gets into contact with the peritoneum or the diaphragm, this results in severe pain for the patient.

To avoid the necessity of multiple treatment sessions, a so-called single-shot therapy with ethanol was created. The ethanol volume used in a single session sometimes reached 250 ml (!), so this procedure can only be carried out under general anaesthesia. Until today, this has been performed mostly in patients with large HCCs; only two studies reported the treatment of liver metastases using this modality. An advantage of this way of treatment is the reduction of treatment sessions, accepting the higher risk of general anaesthesia and a higher complication rate (peritoneal bleeding).

RF ablation

RF ablation works in the same way all surgeons know this procedure from the operation theatre. For the treatment of liver tumours, an RF needle, which is insulated along the shaft and has a leading, non-insulated tip, is inserted into the tumour under US guidance. Grounding is achieved by attaching a large grounding pad to the patients skin near the coagulation area. By applying RF – energy over the electrode tip, a thermal coagulation necrosis of the tumour tissue is achieved (Fig. 2). The RF energy applied ranges from 20 W to 50 W, and the treatment time for each tumour ranges from 5 min to 15 min, depending on the tumour size. By varying RF energy and therapy time, a thermal destruction with a diameter up to 40 mm can be achieved. Figure 3 shows the tip of a needle type which is used in our US lab (Berchtold Medical Electronics, Tuttlingen, Germany). You can see the non-insulated leading tip and the beginning of the teflon insulation covering the whole proximal shaft of the needle. At the proximal end, the needle has an electric connector for the RF cable and a luer lock for the rinsing solution. This rinsing solution (we use isotone sodium chloride) cools the heated area at the tip to prevent the occurrence of vapour or charring tissue, which would lead to a bad

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**Fig. 1** Sonographically guided ethanol injection into a liver tumour

**Fig. 2** Schematic image of radio-frequency (RF) ablation of liver tumours

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