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Treatment of hepatic and pulmonary metastases with radiofrequency

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Abstract Although metastatic disease indicates diffusion of a cancer at a distance from its site of origin, in some cases pulmonary and hepatic metastases are isolated and slowly progressive, making them suitable for local treatment. Thermo-ablation techniques are associated with low morbidity and reduced collateral parenchymal damage; they therefore play an important role in such patients, where the disease is slow and chronic, requiring repeated local treatments. Unlike radiotherapy, a second treatment is possible in the event of local failure.

Principle

The current produced by radiofrequency (RF) is a sinusoidal current of 400 to 500 KHz. Tissues that are traversed by this current undergo ionic agitation, which generates heat through inter-particulate friction [1]. The aim is to expose the neoplastic cells to a temperature of more than 60 °C, which provokes almost immediate and irreversible cellular denaturation. The maximum diameter of the zone of tissue destruction induced by a simple needle electrode of RF is only 1 to 1.5 cm, which is not suitable for the treatment of hepatic tumours. Depending on the manufacturers, various techniques are used to increase this area of destruction:

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- a needle containing several electrodes (4—12), which are deployed after insertion in the target tumour (Figs. 1 and 2). The aim is to obtain as many single small RF lesions as electrodes, to create a larger area by summation. The size and shape of the final lesion therefore depends, among others, on the number of electrodes used, and of their disposition in space;
- cooling of the electrodes via circulation of cold liquid in the sheath of the electrode limits the accumulation of heat to the surrounding tissue, which makes it possible to deliver more electric energy without exceeding 100 °C in the tissues very close to the electrode which are subjected to greater RF energy than more distant tissues. We thus increase the maximal size of the RF lesion that one can induce;

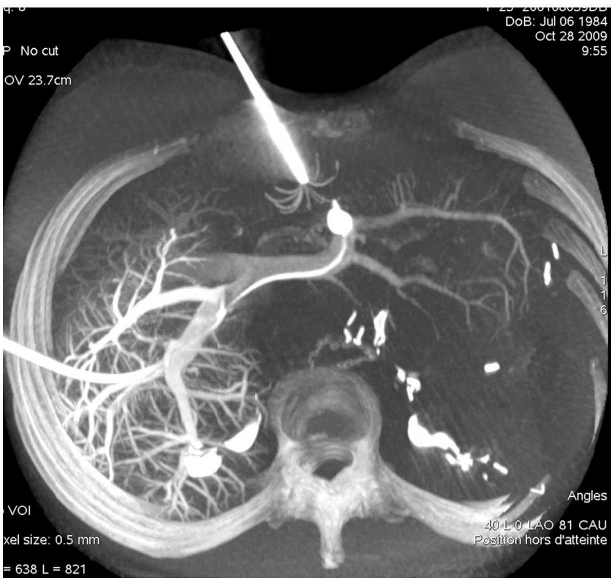

Figure 1. 3D conebeam-CT image of a radiofrequency treatment using a deployable needle, of a metastasis close to the REX recess, during selective portal occlusion obtained via a left trans-hepatic approach with a balloon catheter.

- bipolar electrodes make the RF current circulate between two distinct parts of the same needle or between two different needles. There is therefore no need for grounding pads on the skin, unlike for all other monopolar systems. The electrical field is confined between the electrodes and can therefore be more intense. Finally, the generators can cope with several needles, therefore several poles to make the current circulate successively between different pairs of electrodes to cover a larger surface area and achieve a greater volume of destruction. This technique is therefore often (incorrectly) termed ''multipolar'', whereas it is actually comprised of several successive bipolar applications. These make it possible to increase the size of the RF destruction zones.

Indications

Whether in the lung or liver, the majority of surgeons limit treatment to tumours under 5 cm in diameter, given that the ideal indication is for tumours under 3 cm, as the failure rate is higher above this [2—4]. The treatment of tumours that are larger than those that can be destroyed with a single dose of RF require overlapping impacts, which takes time and is always less effective than a single treatment. To understand this significant reduction in efficacy for a seemingly moderate increase in tumour size, it is important to understand that a 5 cm diameter tumour is approximately twice as voluminous as a 4 cm tumour, and likewise for a 4 cm tumour compared with a 3 cm tumour. Furthermore, although a RF system is capable of covering a sphere of tissue destruction of 4 cm in diameter in one impact, 6 RF impacts are required to cover a sphere of 5 cm.

The ideal localisation is at a distance from the hepatic capsule or pleura, and at a distance from the hiluses. Contact with a large vessel has been reported as a predictive factor for the failure of radiofrequency treatment of hepatic and pulmonary metastases [2—4]. This is due to the cooling by convection that is exerted close to the vessels.

Figure 2. Pulmonary metastasis of the lower right pulmonary lobe within which a radiofrequency needle has been deployed (a). The CT scan taken 10 min after radiofrequency treatment shows the tumour surrounded by a zone of alveolar condensation, which corresponds to the zone of destruction (b). The pneumothorax visible on this image has been punctured and will be aspirated. No drain will be left in place as this pneumothorax will not recur after aspiration. On the CT scan obtained 2 months after the radiofrequency, there is a zone of condensation that will slowly decrease over time (c).