Letter to the Editor

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RE: Should We Use a Monopolar or Bipolar Mode for Performing No-Touch Radiofrequency Ablation of Liver Tumors? Clinical Practice Might have Already Resolved the Matter Once and for All

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Dear Editor,

After a deep reading of the experimental study by Chang et al. (1), we would like to express how we appreciate their considerable scientific efforts in bringing relevant evidence regarding bipolar mode and no touch concept ablation for the treatment of liver tumors. We fully agree that, beyond the need to insert several applicators, the key point for performing a successful and safe no touch ablation is how the energy is delivered from the applicators. High density electromagnetic fields induced sequentially between several dipoles formed by two separate electrodes functioning in bipolar mode (multi-bipolar) ensure a quicker and more predictable ablation zone than the same arrangement of electrodes, but activated sequentially in monopolar mode (multi-monopolar) (2). While using the multi-bipolar mode, the geometry of the ablation zone is closely related to the whole three-dimensional arrangement of electrodes. In the same geometrical configuration, the multi-monopolar mode induces a composite ablation zone resulting from the action of each electrode having variable additional synergic effects (3).

In vivo studies, and even more clinical use of no touch ablation, might emphasize the differences between the two modes, the differences that are already obvious in this *ex vivo* study. Radiating centrifugal energy deposition of monopolar radiofrequency ablation (RFA) is well-known as being highly sensitive to the cooling effect of macrocirculation and microcirculation of blood (4). Hence, no touch ablation, using a multi-monopolar mode, implying the insertion of electrodes into well perfused parenchyma surrounding the tumor, might be strongly and quickly challenged by the size of the target and its vascularisation. Technically, the only way to overcome this inherent weakness of multi-monopolar no touch RFA is to improve the spatial distribution of energy deliverance around the tumor, which can be done by increasing the number of electrodes used and marginally enlarging their diameter (3). However, such a solution limits the clinical suitability of the multi-monopolar mode for no touch ablation in comparison with the multi-bipolar mode, which can ensure, with a similar arrangement of electrodes, a better and quicker temperature increase in the tissue circumscribed by electrodes, as the authors have shown. Thus, in clinical practice, while the efficacy of multi-monopolar use in the no touch technique is likely impeded to induce confluent necrosis of the tumor inside the arrangement of electrodes, outside, there is a trend to overextend the ablation. This point is perfectly demonstrated by the experiments of Chang et al. (1); who rightly anticipated that it could be a serious issue in terms of safety.

For all of these reasons, in 2006, a multi-bipolar device was adopted in our department for the treatment of large liver tumors (> 5 cm), and we conceived the no touch concept for the ablation of smaller tumors (< 5 cm) (5). At

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the beginning of our experience, the outcome of patients treated with no touch RFA confirmed both the effectiveness and safety of the multi-bipolar mode (6). Our attention was drawn by the remarks of the authors concerning the ablation time and the large amount of energy to be delivered for multi-bipolar no touch RFA leading to a large ablation outside of the index tumor. We would like point out that for the treatment of hepatocellular carcinoma, safety margins smaller than 2 cm but larger than 1 cm significantly improve the local tumor progression free survival of patients (7, 8). Hence, the fact that ablation zones largely exceeded the index tumor did not result from uncontrolled treatment but rather a deliberate therapeutic plan. In this setting, the time of energy deposition was in fact quite short regarding the volumes of ablations achieved. However, if for safety purposes, the extent of the ablation zone outside of the arrangement of electrodes must be minimized, the output of the generator must be increased. The rational of this adjustment is that, in bipolar mode, the higher the power, the faster the ablation between dipoles, leading to quicker rises in impedance inducing RF shut down, which shortens the duration of energy deliverance and therefore the time for passive thermal conduction outside the arrangement of electrodes.

Lastly, we would like express to the authors how their study increases our enthusiasm, because it announces further developments and fruitful scientific exchanges in the field of this major topic, the no touch concept for tumor ablation.

Conflict of Interest

Olivier Seror is consultant for Olympus/Celon Company, Angiodynamics, General Electric Healthcare Systems and Bayer Healthcare.

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Response

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We appreciate Dr. Seror's thoughtful comments on our article.

As you have pointed out, Shi et al. (1) showed that a 2 cm resection margin (i.e., larger than 1 cm) improves local tumor progression-free survival of patients with hepatocellular carcinoma (HCC) in surgery. We agree that a safety margin larger than 1 cm could be an effective option for reducing the local tumor progression rate after local treatment of HCC. But regarding local ablation therapy for HCC, an optimal safety margin has not yet been determined, since local ablation therapy is more frequently used in patients with a limited hepatic functional reserve than with surgical resection. What is more, Nakazawa et al. (2) demonstrated that a safety margin even greater than 5 mm is the most important factor for local tumor progression in HCC patients treated with radiofrequency ablation (RFA). Furthermore, Kim et al. (3) showed that a margin greater than 3 mm is associated with a lower local tumor progression rate after percutaneous RFA for > 2 cm and < 5 cm HCC when the ablative margin was evaluated by CT image fusion. Microwave ablation (MWA) is known to be more advantageous for the creation of a bigger volume ablation than RFA which assures a large safety margin. In a meta-analysis comparing MWA and RFA for hepatic lesions, however, MWA showed lower local tumor progression rates for hepatic metastases, while there were no differences in 1–5 year local tumor progression rates for HCCs (4). Most cases of HCC are associated with liver cirrhosis and one of the major non-tumor related causes of death in patients with HCC is liver failure. Therefore, in patients with HCC and liver cirrhosis, it is necessary to find a balance between lowering the local tumor progression rate by creating larger safety margins with RFA and preserving hepatic functional reserves when we plan an ablation zone before an RFA procedure. In other words, the safety margin should be large enough to control the local tumor progression, but not be too big to injure the surrounding liver parenchyma causing functional deterioration or damage to adjacent organs. To set the optimal safety margin, further studies are required.

We agree with Dr. Seror's opinion that a bipolar or multibipolar RFA is more advantageous as a no touch tumor ablation technique than monopolar RFA, because bipolar RFA can induce a high density of electric currents between the electrodes while a monopolar RFA creates a centrifugal energy deposition. Also, we concur with Dr. Seror's suggestion that, for safety purposes, the generator output must be increased in a bipolar mode to minimize the ablation zone's extent outside the electrode arrangement. Considering that a higher RF energy deposition between the electrodes in bipolar mode may create a faster ablation, lead to a rapid impedance rise, and roll off in a shorter time compared with monopolar RFA, it is expected that there is less time for passive thermal conduction outside the electrode arrangement. Furthermore, we believe that the longer ablation time and the large amount of energy delivery for multibipolar no touch RFA were mainly caused by the large size of the target tumors as reported in previous studies by Seror et al. (5, 6). Despite the aforementioned advantages of bipolar RFA, its downside is the greater technical difficulty of controlling an impedance rise compared to monopolar RFA, which may be attributed to the higher density current deposition between the electrodes. In this situation, switching monopolar RFA could be the alternative, since our previous *in vivo* study demonstrated that switching monopolar RFA could achieve a high rate of confluent necrosis comparable to bipolar RFA (7).

We believe that your comments have enriched our study and deeply appreciate your attention.

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