Typical and atypical appearance of microwave ablation zones in the liver

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Abstract

Various local ablation procedures currently used to treat liver lesions lead to a number of characteristic imaging phenomena in the post-interventional follow-up. By considering these normal changes as well as possible pitfalls and sources of error, radiologists can reliably assess the success of treatment.

Keywords: *microwave ablation, post-interventional imaging, HCC, oligo-metastasis*

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Liver ablation techniques

Different minimally invasive local therapeutic procedures have become routine clinical practice for the treatment of malignant liver lesions such as early hepato-cellular carcinoma (HCC) or oligo-metastasis. Commonly used thermal ablation techniques include radiofrequency ablation (RFA), microwave ablation (MWA), and cryotherapy (1-3).

Microwave ablation uses heat to induce coagulation necrosis of a defined tissue area (4). The heat though is generated by applying high-frequency electro-magnetic energy (915 MHz to 2.45 GHz). Microwaves cause polar molecules like water to spin more rapidly (1-5 billion times per second). The agitation results in frictional heat, causing thermal destruction of exposed tissue (5).

Post-interventional findings

Radiologists interpreting images of the post-interventional liver should be familiar with both typical changes occurring after local ablation. With some variations depending on the technical specifications of the ablation probe used the typical ablation zone is slightly oval with a long axis diameter in the direction of the probe shaft. Heat coagulation eliminates perfusion.

A 12 mm diameter arterial hyper perfused hepato-cellular carcinoma serves as an example (Fig. 1A, dotted circle). After heat application an ablation zone has low attenuation compared to surrounding liver tissue in all phases of a dynamic contrast enhanced CT scan both immediately after ablation and in later follow-up examinations (Fig. 1B).
In addition, CT will show a rim of high attenuation (in MRI higher signal) around the ablation zone, which is most conspicuous during the arterial phase and may persist for a few months (Fig. 1B). This rim indicates reactive hyperemia induced by an inflammatory response to heat and subsequent formation of granulation tissue (6,7). Images taken immediately after an intervention often show a linear hyperattenuation within the ablation zone consistent with hemorrhage along the probe track (Fig. 1B).

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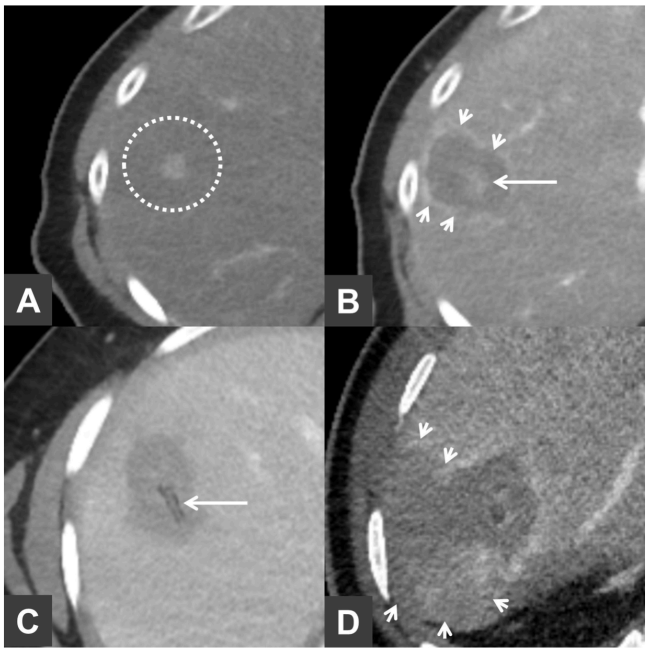
Fig. 1 - Typical and atypical appearance of microwave ablation zones in the liver

A) Arterial hyper-perfused hepatocellular carcinoma (dotted circle).
B) Ablation zone shows low attenuation compared to surrounding liver tissue in all phases of a dynamic contrast-enhanced CT scan, both immediately after ablation and in later follow-up examinations. CT will show a rim of high attenuation (in MRI: higher signal) around the ablation zone, which is most conspicuous during the arterial phase and may persist for a few months (arrowheads). This rim indicates reactive hyperemia induced by an inflammatory response to heat and subsequent formation of granulation tissue. Images taken immediately after an intervention often show a linear hyper-attenuation within the ablation zone, consistent with hemorrhage along the probe track (arrow).
C) Low attenuation along the probe track immediately after ablation indicates pure coagulation necrosis and may persist for some time.
D) Irregularly configured ablation areas due to uncontrolled lateral heat release (arrowheads), e.g. high grade liver cirrhosis.



Conversely low attenuation along the probe track immediately after ablation indicates pure coagulation necrosis and may persist for some time (Fig. 1C) (8). However patients with higher grade liver cirrhosis may experience uncontrolled loss of heat during ablation. This leads to irregularly configured ablation areas due to uncontrolled 3-D-lateral heat release (Fig. 1D, arrowheads).

Conclusion

In summary different local ablation procedures currently in use for treating liver lesions lead to a set of characteristic imaging phenomena in post-interventional follow-up. Bearing in mind these normal changes along with possible pitfalls and sources of error radiologists are able to reliably assess treatment outcome.

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Conflict of interest:

The author declares that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.