

Typical and atypical appearance of microwave ablation zones in the liver

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Abstract

Image-guided local ablation is used to treat selected primary and metastatic liver tumors. Contrast-enhanced CT or MRI is essential for assessing technical success, detecting residual or recurrent tumor, and identifying complications. This pictorial review summarizes typical early and follow-up appearances after thermal ablation and highlights findings that may mimic viable tumor. Accurate interpretation requires attention to enhancement rather than attenuation or signal intensity alone, the expected evolution of the ablation zone, and the distribution of peripheral enhancement.

Keywords: microwave ablation; post-ablation imaging; hepatocellular carcinoma; oligometastases

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Liver ablation techniques

Minimally invasive local ablation is established for selected malignant liver lesions, including early-stage hepatocellular carcinoma (HCC) and oligometastatic disease. Common heat-based techniques include radiofrequency ablation (RFA) and microwave ablation (MWA); laser-induced thermotherapy has also been used [1-3].

Microwave ablation induces coagulative necrosis by depositing electromagnetic energy in tissue. Clinical systems commonly operate at 915 MHz or 2.45 GHz. Interaction of the alternating electromagnetic field with polar molecules and ions produces dielectric heating; the resulting temperature rise causes irreversible cellular injury and coagulative necrosis [4,5].

Post-interventional findings

Radiologists interpreting the post-ablation liver should be familiar with typical and atypical post-ablation findings. The ablation zone is usually ovoid, although its shape depends on the device, antenna configuration, tissue properties, local perfusion, and treatment parameters. Heat-based ablation eliminates perfusion within successfully treated tissue.

Figure 1A shows a 12-mm arterially hyperenhancing hepatocellular carcinoma (dotted circle). Immediately after treatment, the ablation zone is usually nonenhancing and may appear hypoattenuating relative to contrast-enhanced liver parenchyma (Fig. 1B). Its size and internal CT or MRI appearance evolve over time.

A thin, smooth, uniform peripheral rim of enhancement can represent reactive hyperemia and later inflammatory or fibrotic change. In contrast, irregular, nodular, or eccentric peripheral enhancement should raise concern for residual or recurrent tumor and requires correlation with prior imaging and follow-up [7,8].

On unenhanced CT, linear hyperattenuation along the antenna track may reflect hemorrhage (Fig. 1B). Low attenuation along the track may correspond to coagulative necrosis and can persist during early follow-up (Fig. 1C).

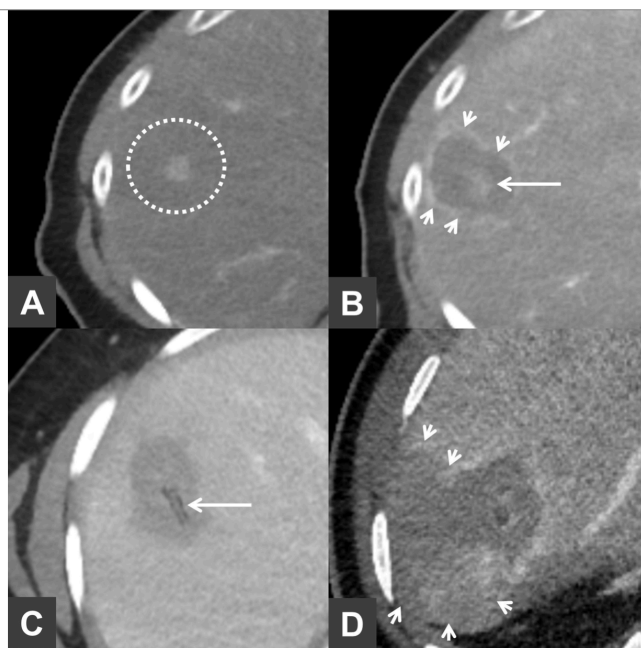
Fig. 1 · Typical and atypical appearance of microwave ablation zones in the liver

A) Arterially hyperenhancing hepatocellular carcinoma (dotted circle).

B) Nonenhancing ablation zone with a thin, smooth peripheral rim of enhancement (arrowheads) and possible hemorrhage along the antenna track (arrow) on unenhanced CT.

C) Low attenuation along the antenna track, compatible with coagulative necrosis (arrow).

D) Irregularly configured ablation zone. Morphology may be influenced by heterogeneous tissue properties, local perfusion, antenna position, and technical treatment parameters (arrowheads).



Irregular ablation-zone morphology may reflect heterogeneous tissue properties, local perfusion and heat-sink effects, antenna position, or technical treatment parameters. Such morphology should not be attributed to cirrhosis alone and should be interpreted together with the planned ablation margin and contrast-enhanced follow-up imaging (Fig. 1D).

Conclusion

Local ablation produces expected imaging changes that evolve over time. Familiarity with the normal nonenhancing ablation zone, transient smooth peripheral enhancement, antenna-track changes, and suspicious irregular or nodular enhancement can support assessment of treatment response and identify findings that require further evaluation. Interpretation should incorporate the ablation protocol, planned treatment margin, prior imaging, and serial contrast-enhanced follow-up.

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.

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