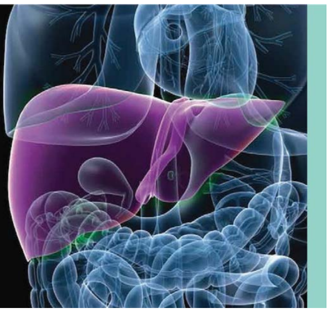

Primer on Percutaneous Ablation of Benign Liver Tumors

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Simple cysts, hemangiomas, adenomas, and focal nodular hyperplasia (FNH) are the most common benign tumors in the liver and are more often found in women.[1] Simple cysts and hemangiomas are often incidental findings in asymptomatic patients and require no specific follow-up or intervention. Giant cysts and hemangiomas are uncommon but may require intervention to relieve associated symptoms. Hepatic adenomas, in contrast, require imaging follow-up and/or curative-intent treatment because of the risk for hemorrhage and malignant degeneration. Tumor ablation is a minimally invasive, low-morbidity treatment alternative to surgery for adenomas and symptomatic benign liver tumors. The purpose of this article is to provide a primer on percutaneous ablation of benign liver tumors.

This article does not contain any studies with human participants or animals performed by any of the authors.

TUMOR ABLATION

Broadly, tumor ablation is the destruction of a tumor after the direct application of chemicals or energy.[2] Tumor ablation therapies are administered via needle-like applicators and can be categorized into chemical (ethanol, acetic acid) and energy (thermal and nonthermal). Radiofrequency (RF), microwave (MW), and cryoablation are the most widely applied thermal ablation modalities. Both RF and MW create zones of coagulative necrosis through the application of heat. With RF, an alternating current is conducted through an applicator (electrode) that serves as a cathode in a closed electrical circuit with grounding pads (applied to the skin) serving as the anode. Resistive heating occurs in tissues immediately adjacent to the electrode (~2 mm). Heat is then conducted into surrounding tissues as a result of the high thermal gradient.[3] Therefore, tissue conductivity and local factors, such as perfusion, play a substantial role in the size and shape of

Abbreviations: CT, computed tomography; FNH, focal nodular hyperplasia; MRI, magnetic resonance imaging; MW, microwave; RF, radiofrequency.

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the final ablation. With MW, an oscillating electrical field is applied to tissue from the emission point, near the tip of an applicator (antenna). Polar molecules—water, for example—are forced to continuously align with the field (dielectric hysteresis) in a volume of tissue surrounding the antenna (~20 mm). This mechanism of heating creates larger ablations that achieve higher tissue temperatures and are less susceptible to local tissue factors. Further, MW applicators can be powered simultaneously, harnessing thermal and electromagnetic synergy, to create very large ablations.[4]

BENIGN LIVER TUMORS

Simple cysts are surrounded by a thin fibrous capsule, lined with a single layer of cuboidal or columnar epithelium that produces a clear to yellow acellular fluid and does not communicate with the biliary tree. Hemangiomas are encapsulated, composed of cavernous vascular spaces, lined by a single layer of flat endothelium, and filled with blood. Simple cysts and hemangiomas are generally small (<5 cm), demonstrate minimal to no growth, and usually follow an indolent course.[5,6] Infrequently, simple cysts and hemangiomas can become very large, resulting in pain attributed to stretching of Glisson's capsule or symptoms, such as nausea, early satiety, anorexia, and fullness, associated with local mass effect on adjacent anatomy.[6,7] Importantly, spontaneous or traumatic rupture of simple cysts and hemangiomas, even those in a subcapsular location, is rare.[8,9]

Hepatic adenomas are composed of plates of cells closely resembling hepatocytes that are separated by dilated sinusoids and lack bile ducts, a key histological feature distinguishing FNH. These dilated sinusoids are morphologically similar to thin-walled capillaries. Importantly, hepatic adenomas are perfused exclusively from feeding arteries and lack a substantial connective tissue framework. Therefore, these sinusoids, subjected to arterial pressures, are prone to rupture, and because adenomas generally lack a complete capsule, hemorrhage can extend throughout the liver or into the peritoneal cavity.[10]

Compared with other benign tumors, management of hepatic adenomas is more complex because of the risk for hemorrhage and malignant degeneration, particularly inflammatory and beta-catenin activation subtypes.[11] Because the natural history and associated risks of hepatic adenomas are not well established, management generally revolves around patient symptoms, tumor size, location, and number. Patients with (1) adenomas who are or wish to become pregnant, (2) symptoms attributed to the adenoma, (3) adenomas >5 cm, and (4) adenomas that fail to regress after the discontinuation of contraceptive medications usually proceed to local curative options.[12]

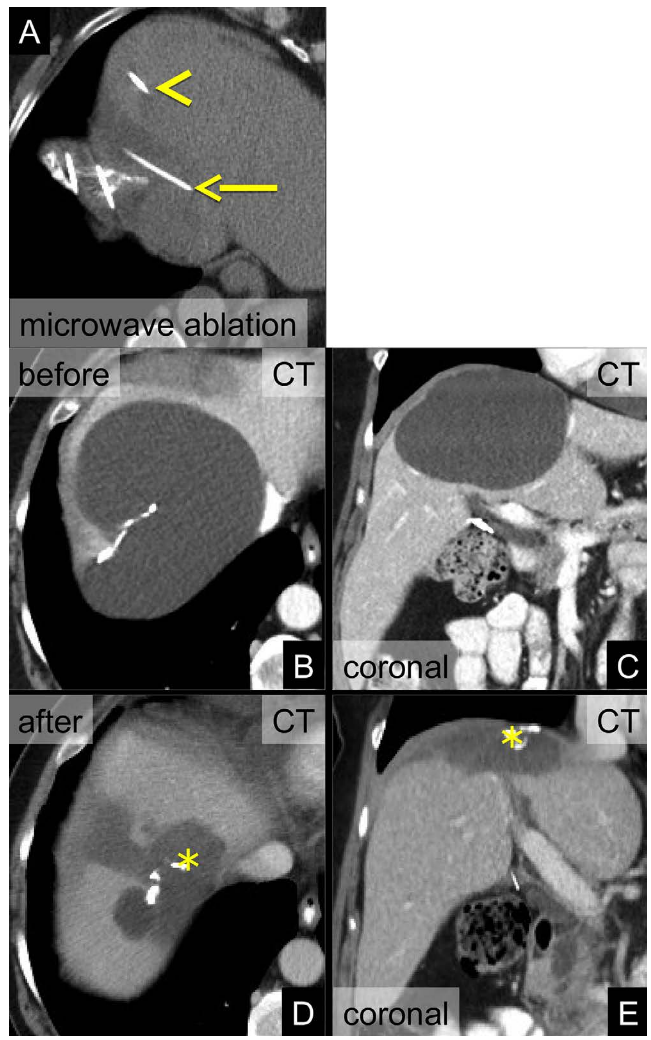

FIG 1 Computed tomography (CT) before, during, and after MW ablation of a large, symptomatic hepatic cyst. (A) Three MW antennas (arrow) were placed into the previously fenestrated, recurrent large cyst in the dome of the liver. MW ablation was performed after near-complete aspiration of the cyst (arrowhead). The residual cyst fluid, subjected to very high temperatures, conducts lethal temperatures to the cyst wall. At 1-year follow-up CT after ablation (D, E), the cyst (*) (B, C) remains decompressed, and the patient endorses durable relief from abdominal symptoms.

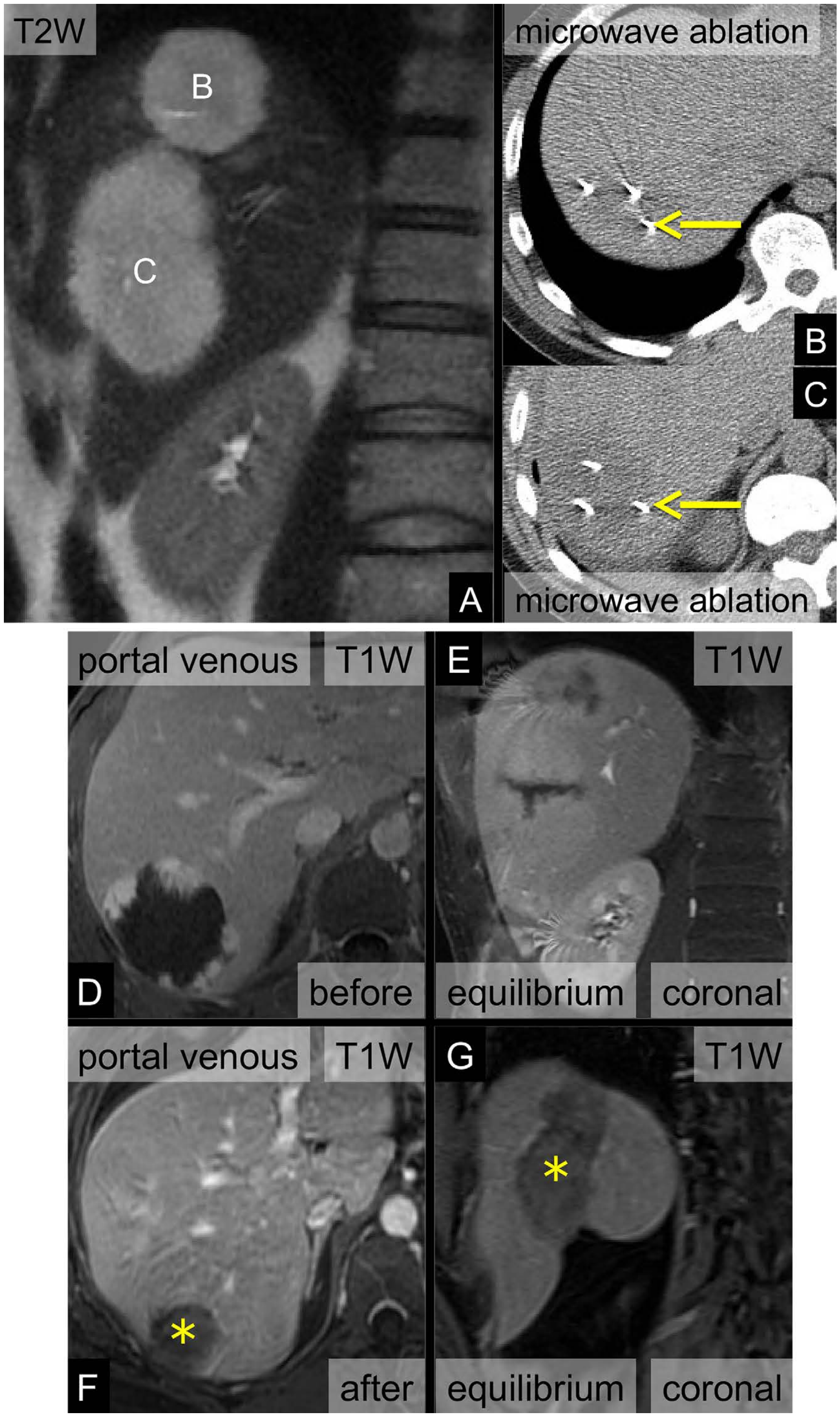

FIG 2 Magnetic resonance imaging (MRI) before and after MW ablation and CT during MW ablation of giant hemangiomas. Before placement of the MW antennas, fluid was instilled into the abdomen (hydrodissection) to protect the diaphragm from thermal injury (not shown). Three MW antennas (arrow) were placed into the hemangioma in segment 7 (A, B), and an ablation cycle was performed. The antennas (arrow) were removed and then placed in the segment 6 hemangioma (A, C), and another ablation cycle was performed. At 1-year follow-up MRI after ablation (F, G), the hemangioma is dramatically smaller (D, E), and the patient endorses durable relief of abdominal symptoms.

ROLE OF ABLATION FOR BENIGN LIVER TUMORS

Patients with benign hepatic tumors may be the ideal candidates for ablation. Cysts and hemangiomas have zero malignant potential; therefore, achieving complete ablation and a margin are not necessary. Symptomatic cysts and hemangiomas are often large and easily exceed a size threshold that would be appropriate for ablation of malignancy. However, given their benign nature, debulking or shrinking the mass without achieving complete necrosis generally achieves the desired endpoint.[13] This is particularly important when ablating cysts and hemangiomas in proximity to critical structures, such as the hilar plate or colon. Hence, successful ablation procedures relieve patient symptoms while preserving liver parenchyma and sparing nontarget anatomy (Figs. 1 and 2).

The approach to ablation of adenomas differs from cysts and hemangiomas. Complete destruction of the adenoma including a margin is necessary to mitigate the risk for hemorrhage and malignant degeneration[12,14] (Fig. 3). Therefore, size and location of the adenoma are important factors when considering ablation as a treatment option. In general, adenomas up to 5 cm, and perhaps larger depending on the proximity of nontarget anatomy, can be effectively treated with MW ablation.[12]

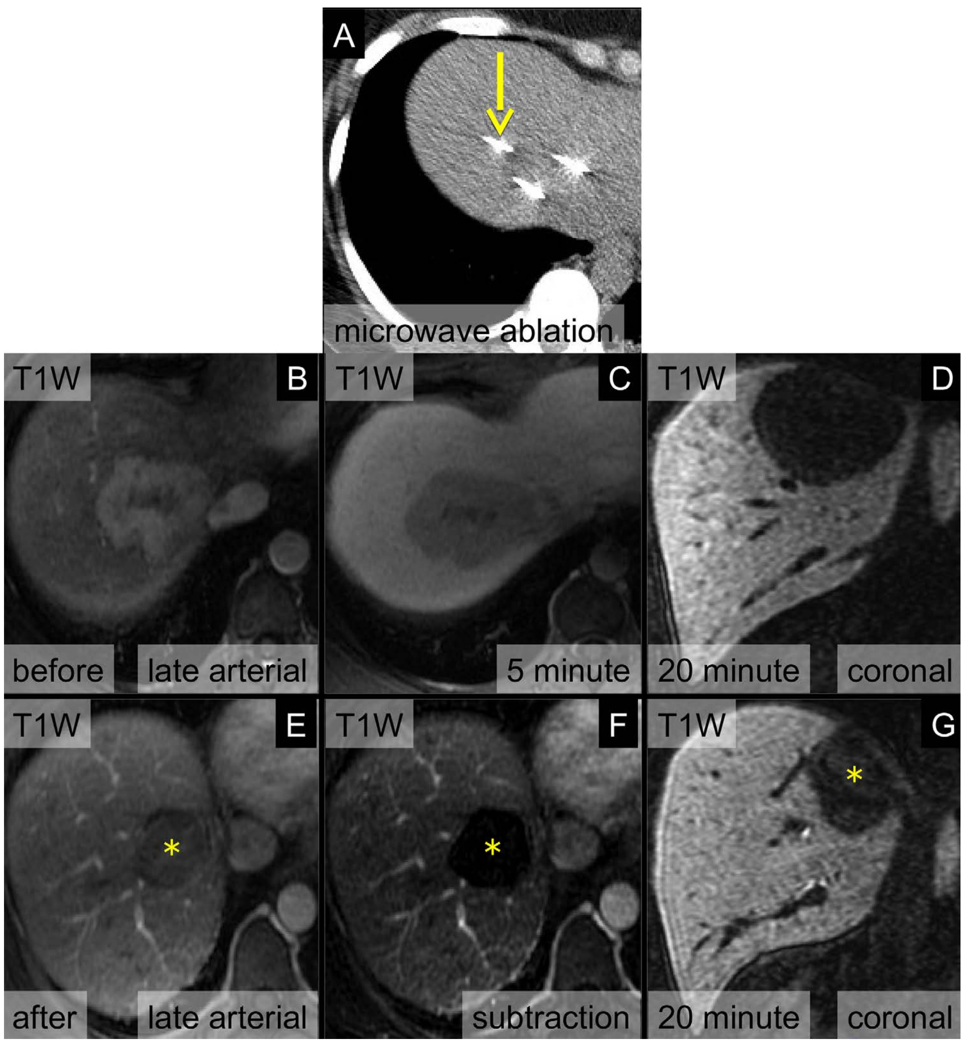

FIG 3 Magnetic resonance imaging (MRI) before and after MW ablation and CT during MW ablation of hepatic adenoma. Three MW antennas (arrow) were placed into the adenoma in the dome of the liver (A), and an ablation cycle was performed. Complete ablation including a narrow margin is important when treating adenomas to eliminate the risk for complications, including hemorrhage and malignant degeneration. At 1-year follow-up MRI after ablation (E, F, G), the treated adenoma (*) is much smaller (B, C, D), and there is no enhancement within or adjacent to the treated adenoma to suggest residual or recurrent tumor.

CONCLUSION

Percutaneous tumor ablation procedures are safe and well tolerated, can be performed in an outpatient setting or with overnight in-hospital observation, have an abbreviated convalescent period, and are associated with a very low readmission rate.[15] Therefore, percutaneous ablation is an appealing treatment option for patients with benign liver tumors.

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