Percutaneous and Intra-operative Tumor Ablation

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KEYWORDS

• Tumor ablation • Intra-operative • Radiofrequency ablation • RFA • Cryoablation

KEY POINTS

- Percutaneous and intra-operative ablation procedures may offer curative or bridging, minimally invasive treatments to patients who are unable to undergo surgical resection for local tumor control.
- Careful preprocedural patient evaluation and postprocedural management are imperative in obtaining positive treatment results.
- Percutaneous tumor ablative therapies have shown efficacy in local tumor control in a variety of organs and tumor types, most commonly within the liver and kidneys.

INTRODUCTION

The past 2 decades have brought with them significant technological development and advancement in image-guided tumor ablation. The drive for this development is the discovery and application of minimally invasive methods to treat solid tumors locally without adjacent tissue damage. This strategy allows clinicians to broaden the patient population eligible for curative treatment and reduce morbidity and mortality associated with tumor resection. Tumors are now commonly treated with percutaneous and intra-operative (mostly laparoscopic) ablative therapies, especially in the liver and kidneys. Despite nuances in techniques, ablation is generally accomplished via placement of probes into the tissue of concern and induction of local cell death via various ablative mechanisms. Chemical ablation, such as direct tumor injection with ethanol or acetic acid, has largely been supplanted by thermal ablative techniques.[1] Many different technologies are available for ablation, including specialized probe technology and various methods of image guidance.

Thermal ablation can be accomplished by using probes that generate heat from radiofrequency (RF), microwaves, laser, or focused ultrasound, or alternatively by probes that cool tissues to lethal temperatures, called cryoablation. These ablative technologies have been extensively used over the past decade and have shown favorable results for minimally invasive destruction of focal solid tumors with relatively low morbidity and mortality, especially in individuals who are not operative candidates or do not wish to undergo surgical resection.[1,2] The goal of tumor ablation is to destroy all tumor cells in a mass as well as malignant cells adjacent to the visible tumor. As a result, the ablative therapy should include a 1-cm margin surrounding the target mass.[3] This strategy must be balanced with attempts to preserve surrounding normal tissue.

RF ablation (RFA) is the most commonly used and studied form of tumor ablation. Thus, we focus our discussion on RFA and only briefly discuss cryoablation. Other ablative methods are beyond the scope of this text and are not discussed. This article reviews the indications, preprocedural

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patient evaluation, techniques, postprocedural management, and complications of ultrasound-guided percutaneous and intra-operative tumor ablation, with special attention to hepatic and renal neoplasms.

PLANNING AND PREPROCEDURAL CONSIDERATIONS

All patients undergoing tumor ablation with ultrasound guidance should be evaluated with a complete history and physical examination, and special attention should be paid to history of bleeding disorders, reactions or allergies to sedative or anesthetic medications, body habitus, and ability to position the patient appropriately (ie, patients unable to lie flat because of heart failure require a more specific plan). Each patient's comorbidities should be considered in addition to the possibilities of multiple tumors being present and the functional reserve of the organ of interest. Before a therapeutic ablation, the patient should have a full imaging and pathologic diagnostic workup. Often with liver, renal, or adrenal masses, cross-sectional imaging with intravenous contrast is performed for diagnostic evaluation and preprocedural planning purposes. In addition to aiding in diagnosis, the imaging allows for visualization of the patient's relevant anatomy and planning of approach with a necessary evaluation of intervening structures such as bowel. Diagnostic ultrasonography before the procedure also helps in evaluating how well the lesion can be seen with ultrasound during the forthcoming procedure. Biopsy before ablation may be performed but is controversial and may not be necessary in some settings in which history and imaging point to a specific diagnosis. Occasionally, small tissue samples can come back with inconclusive pathologic results and cloud the clinical picture.

Preoperative laboratory evaluation is necessary before the ablation procedure. Most importantly, a coagulation panel helps to rule out bleeding disorders. Complete blood counts establish a baseline hematocrit and white blood cell count to monitor for bleeding or infection if there are signs of complication. A platelet count of greater than 50 to 70,000/mm^3 and an international normalized ratio less than 1.4 are commonly used guidelines followed by many institutions. In addition, bilirubin values less than 3 mg/dL help rule out hepatic failure or obstructive jaundice.[4] These parameters have not been validated specifically, but rather represent a reflection of commonly used guidelines and operator comfort levels. The operator must consider the risks and benefits of the procedure. Metabolic panels, which include liver function tests for liver tumor ablation and creatinine for renal tumor ablations, are helpful to establish baseline values to monitor recovery after the procedure. Obtaining tumor markers such as α-fetoprotein and carcinoembryonic antigen may be helpful in monitoring response in patients with hepatocellular carcinoma (HCC) or colorectal metastasis, respectively. Prophylactic antibiotics should be given within an hour before the procedure.[5]

Tumor size, location, and characteristics are important in preprocedural planning and should be thoroughly addressed. Specifics regarding different tumors and organs are discussed in later sections. In general, tumors must be locally confined, the target must be clear, and sizes greater than 3 to 4 cm are significantly more complicated to treat and usually require multiple sessions to obtain a 0.5-cm to 1-cm ablation margin.[4]

We prefer general anesthesia especially in complicated cases, patients with low pain tolerance and high level of anxiety, large lesions, or when precise breath control is required. Procedures should ideally be performed in a dedicated procedure/operating room with capabilities for endotracheal intubation and appropriate monitoring equipment. Standard surgical sterile technique should be followed by the entire staff involved.[5]

PATIENT AND TREATMENT MODALITY SELECTION

Correct patient selection is critical in planning ablative therapies. Details for specific indications in the liver, kidney, and adrenals are explained in their respective sections later. Increased tumor size carries with it increased risk of complication and risk of leaving behind residual disease. If the tumor location is adjacent to vital structures, careful consideration must be made to approach the areas of concern, and protective measures taken to insulate them. Centrally located tumors generally have larger nearby vessels, resulting in more of a heat-sink effect, and often have more adjacent vital structures that can be injured, such as the biliary tree in the liver or the urinary collecting system in the kidney.

When choosing an ablation modality, all of the factors mentioned earlier must be considered. RFA has the advantage of being the most well studied and likely the most familiar modality for most operators. RFA has an inherent cautery effect on small blood vessels, low cost, and quick ablation times (<20 minutes). Large nearby vessels can create a heat sink and protect a nearby tumor or reduce effective ablation area. RFA is more painful than cryoablation and less effective in treating cystic lesions. Cryoablation has longer