Nonoperative Ablation of Pancreatic Neoplasms

Cristina Marrocchio, MD*[,1], Susan Dababou, MD[1], Carlo Catalano, MD, Alessandro Napoli, MD, PhD

KEYWORDS

• Pancreatic cancer • Minimally invasive therapies • High-intensity focused ultrasound
• Radiofrequency ablation • Cryotherapy • Irreversible electroporation
• Microwave ablation

KEY POINTS

- The prognosis of pancreatic cancer remains dismal. Although surgical resection is the only curative treatment, almost 80% of patients are diagnosed in advanced unresectable stages.
- The noninvasiveness, high-safety, and multimodal approach suggest high-intensity focused ultrasound as a possible treatment in management of unresectable advanced pancreatic cancer, with promising results in terms of pain palliation and tumor control.
- Radiofrequency ablation, microwave ablation, irreversible electroporation, and cryoablation have been used for the management of unresectable locally advanced pancreatic cancer. There is some experience with their intraoperative use; however, in the future, an important role may be fulfilled by percutaneous approaches to reduce risks and morbidity.
- Minimally invasive therapies are promising for unresectable pancreatic cancers to achieve symptoms palliation and local tumor control.

The prognosis of pancreatic cancer remains dismal.[1] Although surgical resection is thought by many to be the only curative treatment, due to the aggressive nature of the cancer and the nonspecificity of symptoms, almost 80% of patients are diagnosed in advanced unresectable stages.[2]

For this reason, in the past few years, a strong effort has been made to investigate the application of minimally invasive ablative techniques for unresectable, locally advanced pancreatic cancer. These procedures, associated with lower morbidity and mortality, have demonstrated positive results on local tumor control and palliation

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Department of Radiological Sciences, Sapienza University of Rome, V.le Regina Elena 324, Rome 00180, Italy
[1] These authors contributed equally to this work.
* Corresponding author.
E-mail address: cristinamarrocchio@gmail.com

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of symptoms. The main limitations and challenges of the treatments are the organ location and the risk to develop pancreatitis or to damage the contiguous neurovascular structures. Studies have described the use of high-intensity focused ultrasound (HIFU), radiofrequency ablation (RFA), microwave ablation (MWA), cryotherapy, and irreversible electroporation (IRE). Some experience has accumulated with the intraoperative use of these techniques; however, in the future, an important step may be fulfilled by percutaneous approaches to reduce morbidity and mortality. Although the clinical applications of minimally invasive therapies for pancreatic cancers are still in their infancy, the results are promising.

HIGH-INTENSITY FOCUSED ULTRASOUND

HIFU is a new totally noninvasive technique approved by the US Food and Drug Administration for the treatment of painful bone metastases, uterine fibroids, and essential tremor. Recently, new applications in oncology, including the management of unresectable pancreatic cancer, are undergoing study and are showing promising results.[3] HIFU, either ultrasound (US)-guided focused US (FUS) (USgFUS) or MRI-guided FUS (MRgFUS), generates and focuses a beam of high-energy US to a precisely defined region of few millimeters, called the sonication spot. In few seconds the energy accumulates, inducing a steep increase in temperature that causes coagulative necrosis in the targeted tissue. HIFU has considerable advantages over other minimally invasive techniques in that it is totally noninvasive, does not use ionizing radiations, and, if MRI-guided, monitors in real-time the temperature reached in the tissue, ensuring a safe and effective ablation.

PREOPERATIVE PLANNING AND PATIENT PREPARATION

Although some variation may be present among the studies, some steps are universally performed before treatment. The patient should be fasting and procedures to displace the bowel from the US beam, such as drinking degassed water or intestinal cleaning, may be used to decrease the chance of adverse events. The patient is positioned prone on the treatment bed with the region to be treated cleaned, examined to exclude the presence of scars, and aligned with the US transducer. A coupling gel or immersion of the area to be treated in degassed water increases the contact with the transducer eliminating any interposed air. The main precaution to reduce any risk of adverse outcomes is to ensure the patient has neither air nor scars interposed in the beam trajectory because they may reflect or absorb heat, causing collateral damage and decreasing the effective dose delivered. MRgFUS and USgFUS require general anesthesia, whereas in pulsed USgFUS local anesthesia is sufficient and sometimes no anesthesia is necessary. Vital signs are monitored during the procedure. If the patient is conscious, a stop button is provided to interrupt the treatment in case of unpleasant sensations.

TREATMENT

Planning

Before the treatment starts, the patient position is checked and the acoustic window is optimized using the diagnostic probe incorporated in the transducer in USgFUS or acquiring T1-weighted and T2-weighted MRI sequences, with and without fat saturation, at the inspiration phase in MRgFUS.

The treatment plan is assessed in 4 phases:

1. Calibration: The orientation and position of the transducer in relation to the target lesion is assessed.