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## Case report: Irreversible electroporation for locally advanced pancreatic cancer

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## ABSTRACT

**INTRODUCTION:** For patients with pancreatic adenocarcinoma who are not candidates for surgical resection, long-term survival is poor, even with currently available systemic and radiation therapy options. However, for those with locally advanced disease who do not have distant metastasis, locoregional control of the tumor has the potential to improve long-term outcomes. A newly developed technology, irreversible electroporation, has advantages over traditional thermal ablation with unresectable cancers in this location.

**PRESENTATION OF CASE:** In our case report, we describe the first patient treated with irreversible electroporation at our institution for locally advanced pancreatic cancer. The patient is a 63-year-old man who had a partial response to standard chemotherapy and radiation, but was found on operative assessment to have persistently unresectable disease. He therefore underwent irreversible electroporation to the pancreatic mass. His postoperative course was complicated by delayed gastric emptying and wound infection. Three months after surgery, he had no evidence of distant or recurrent disease.

**DISCUSSION:** Irreversible electroporation for locally advanced pancreatic cancer is an emerging technique which attempts to improve local control of locally advanced, non-metastatic pancreatic cancer. Early data have demonstrated the potential for improved long-term survival in these patients, although further studies are needed to confirm safety and efficacy of this technique.

**CONCLUSION:** While there is a positive outlook for the use of irreversible electroporation for locally advanced pancreatic cancer, there remain some uncertainties surrounding this therapy, which underscores the importance of future research in this area.

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## 1. Introduction

Locally advanced pancreatic cancer represents 40%–50% of new pancreatic cancer diagnoses, although prognosis is dismal [1,2]. In these patients, the 5-year survival rate is 5% and overall survival ranges from 8 to 16 months [2]. For unresectable patients, ablation is an alternative therapy for local control, which causes local destruction while ideally avoiding injury to surrounding healthy tissue [3]. However, the pancreas is adjacent to several vital structures, which are vulnerable to injury from ablation. In addition, the significant vasculature around the pancreas can limit the success of ablation through a “heat sink,” preventing the tumor from reaching the temperature needed for appropriate ablation [3]. Irreversible electroporation (IRE) is an emerging therapy that avoids these

drawbacks and has shown promise in recent years for the treatment of locally advanced pancreatic cancer. IRE functions through electroporation, by which electric pulses delivered through probes into the tissue create small holes in the cell membrane, known as nanopores. This ultimately results in cell death due to the inability to maintain homeostasis, though maintaining the cell structure. In contrast to thermal ablation, there is no heat sink or transitional zone of partially treated cells [3].

Here, we present a case report of the first patient treated at Moffitt Cancer Center with this technique to target non-metastatic, locally advanced pancreatic cancer that was otherwise unresectable. This case report is compliant with the SCARE guidelines [4].

## 2. Presentation of case

The patient, a 63-year-old healthy man, underwent a computed tomography (CT) scan for assessment of back pain, which identified a mass in the neck of the pancreas. In retrospect, the patient also noted a 10 pound weight loss over the prior month, but he was

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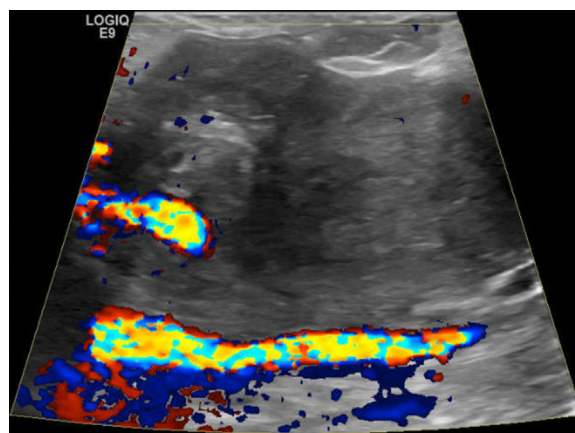
**Fig. 1.** Computed tomography scans demonstrating the patient's unresectable pancreatic cancer. A. Tumor after systemic chemotherapy and radiation therapy but prior to electroporation. B. Tumor after irreversible electroporation.

otherwise asymptomatic. He had no known risk factors for pancreatic cancer.

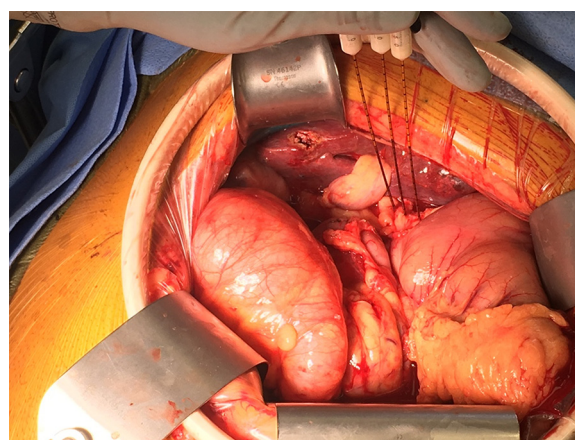
Pancreatic protocol CT identified a  $5.4 \times 4.5$  cm mass in the neck of the pancreas with encasement of the common hepatic artery and narrowing of the confluence of the portal vein and superior mesenteric vein, confirmed on endoscopic ultrasound. CT chest showed indeterminate lung nodules, though not avid on positron emission tomography. Endoscopic retrograde cholangiopancreatography demonstrated a 1-cm stricture in the common bile duct, for which a covered metal stent was placed, and biopsy of the mass demonstrated pancreatic adenocarcinoma. CA 19-9 was elevated at 1079.

For his locally advanced pancreas cancer, he was started on systemic chemotherapy with FOLFIRINOX for 6 cycles, followed by stereotactic beam radiotherapy. He had a good response, with decrease in size of the tumor and no evidence of new lesions (Fig. 1). CA 19-9 decreased to 71. Multidisciplinary tumor board then recommended consideration of surgery due to his good therapeutic response, young age, and good performance status.

Staging laparoscopy identified no distant metastases. Laparotomy and intraoperative ultrasonography confirmed that the mass was still unresectable, as both the common hepatic artery and portal vein were involved by tumor (Fig. 2). IRE was then performed with NanoKnife® (Angiodynamics). As there is limited long-term follow-up in the use of IRE for locally advanced pancreatic cancer, a gastrojejunal bypass was performed to prevent potential future complications from disease progression. A hepaticojejunal bypass was attempted, but radiation therapy and inflammation from the bile duct stent had resulted in significant fibrosis, precluding safe dissection of the bile duct itself.



**Fig. 2.** Ultrasonography image of unresectable pancreatic cancer encasing the hepatic artery and involving the portal vein.



**Fig. 3.** Intraoperative placement of probes for irreversible electroporation.

For IRE, manufacturer's specifications and recommended parameters were followed. [3] Three monopolar electrodes, in linear or triangular configurations, were used to treat sequential parts of the tumor over 4 applications (Fig. 3). The probes were spaced from 0.7 to 1.4 cm apart, and 1.5 cm of the probe tip length was exposed. Eighty pulses were delivered between each probe for each application, and voltage ranged from 1050 to 2100 V/cm. The pulse length was maintained at 90  $\mu$ s. Ultrasound was performed on the ass again, revealing post-ablation changes of increased echogenicity in the ablation zone and patent vessels (Fig. 4).

The patient's postoperative course was complicated by delayed gastric emptying, requiring a week of home supplemental total parenteral nutrition; migration of his biliary stent, requiring endoscopic removal; and a wound infection, requiring wound care. There was no long-term complication from the IRE procedure. At his postoperative visit 3 weeks after surgery, his CA 19-9 remained low at 67. Restaging CT scans at 2 months demonstrated no evidence of metastasis (Fig. 1). He has since recommenced systemic chemotherapy with gemcitabine, which he is tolerating. At 3 months after the procedure, he remains without evidence of disease.

### 3. Discussion

Beyond systemic therapy, patients with locally advanced pancreatic cancer have limited treatment options. However, if local tumor control can be achieved in patients without distant metastasis, there is potential for improvement in long-term outcomes,

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