Irreversible Electroporation for Recurrent Pelvic Metastases: Case Series and Literature Review

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Introduction

Irreversible electroporation (IRE) is a nonthermal ablative technique that has potential safety advantages over thermal ablation in the treatment of tumors near critical structures.[1-5] It creates an electrical field which forms permanent nanopores in the membranes of cells and triggers apoptosis.[1,6] This case series reviews three patients with pelvic metastases from colorectal cancer treated with IRE.

Aims and Objectives

Describe and characterize the procedure and outcomes for a case series of patients receiving irreversible electroporation for recurrent pelvic tumors.

Methods

Patient demographics, treatment details and outcomes are shown in the Table. Thermal ablation was contraindicated due to proximity to ureter, bladder, bowel, and/or sciatic or lumbosacral nerves. Every patient was referred to interventional radiology due to progression after primary tumor resection, FOLFOX chemotherapy, and pelvic radiation.

Results

To reduce IRE risk, in all cases, hydrodissection was performed. In each case, either four or five IRE probes were used with up to two pull back treatments. Probe exposure length was either 1.5 cm or 1 cm, treatment images are shown in Figures 1 and 2. One patient had no recurrence after last follow-up at 23 months.

Two patients had recurrence, one after 3 months due to 8/2219 PET (retreated with IRE) and the other after 17 months. Complications included partially reversible lower extremity sensory and motor deficits, contained colon perforation eventually requiring ileocecectomy, and ureteral injury requiring stent placement.

Conclusions

IRE is a promising tool for local treatment of recurrent pelvic metastases when other local treatments are contraindicated because IRE leaves supporting tissue largely unaffected, so that blood vessels and intestines are relatively preserved, and damaged axons may regenerate.[5] This is important in the pelvis where structures sensitive to thermal ablation include bladder, ureters, bowel, lumbar and sacral nerve roots, and the sciatic nerve. However, to our knowledge there are only 11 patients treated with IRE for pelvic malignancies in the literature. [3,5,7,8] The only report of more than one patient was an 8-patient series with pelvic tumor recurrence treated with IRE.[5] Local tumor control was achieved in 4/9 lesions, one requiring a second procedure. We achieved a similar local control rate of 1/3 with all patients alive after a range of 25-64 months, mean 40 months". For these patients, IRE was selected over thermal ablation due to decreased risk of complications. Complete ablation is possible for smaller lesions, while symptom control should be the focus of larger lesions.

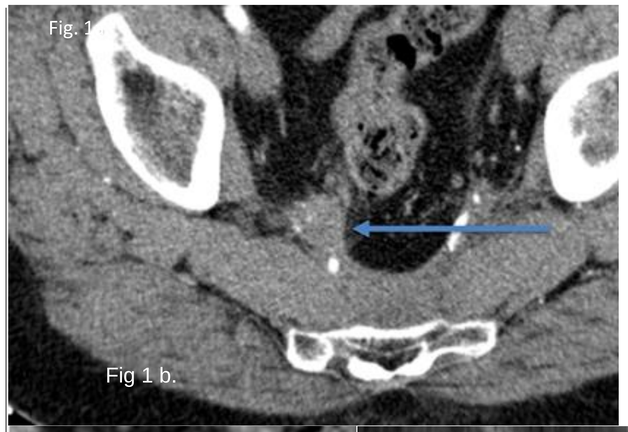
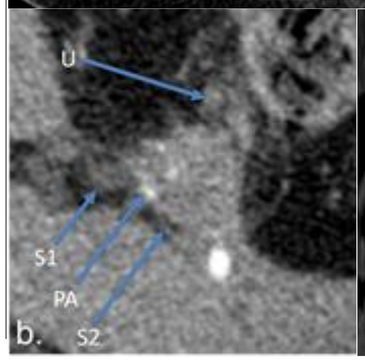
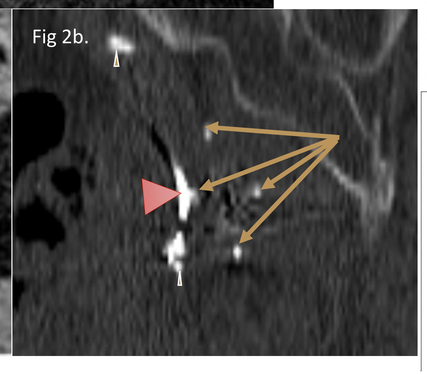


Figure 1a. Patient 1 CT Pelvis. Right internal iliac lymph node metastasis. 1b. Zoomed in view shows adjacent structures: pudendal artery (PA), ureter (U), S1 nerve root (S1), S2 nerve root (S2). Note sigmoid colon was resected prior to IRE.





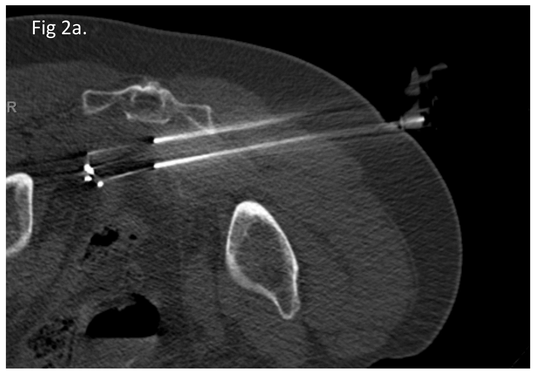


Figure 2a. Patient 1 Intraprocedural CT. 2a. Axial view, 2 IRE probes. Streak artifact from a fiducial marker and endovascular coil between probe tips.
2b. Sagittal view, 4 IRE probes at 4 corners of lymph node metastasis (arrows). Ureteral stent anteriorly (arrowhead) and endovascular coils (small arrowhead).

Table: Overview of Case Series.

Patient	Tx #	Tx Date	Age & Sex	Primary tumor	Treatment of primary tumor	IRE Lesion Size, Location	Pre-IRE Preperation	Vulnerable Structures close to tumor	Complications	Recovery of Neural Function	Time to Local Progression	Time to Distant Progression	Survival from IRE
1	1st IRE	9/19/16	61 M	Rectal Cancer	5-FU, FOLFOX, oxaliplatin+xeloda, neoadjuvant radiation, resection with lymphadenectomy	2.5 x 2.0 cm Right internal iliac lymph node metastasis	2 Right internal iliac artery branches embolized, right ureteral stent placement	Distal right ureter, bladder, S1, S2, S3 nerve roots, 2 branches of Right internal iliac artery	Diminished light touch in right lower extremity, weakness of right knee flexion, weakness of foot dorsiflexion, ureteral stricture requiring chronic stent exchange	Post op day 1 could ambulate with walker, 15 months of physical therapy he could ambulate independently, persistent right leg numbness due other cause	15 months, 12/28/17 PET	None	5 years, 4 months; Alive; 1/3/22 office visit
2	1st IRE	5/20/19	49 F	Colon Cancer	FOLFOX, radiation, multiple resections, panitumumab, HIPEC	3.3 x 2.7 x 2.3 cm Left presacral metastasis	Bilateral ureteral stent placement	Right UVJ, distal right ureter, bladder, abuts bowel	Left posterior thigh, perineal, low buttock numbness and weakness	Much improved but persistent left posterior thigh, perineal, low buttock numbness with occasional shooting pains	3 months; 8/22/21 PET -- Two 1.5 cm lesions	None	31 months; Alive; 12/13/21 MRI
2	2nd IRE	11/25/19	49 F	Colon Cancer	FOLFOX, radiation, multiple resections, panitumumab, HIPEC	Two 1.5 cm left presacral metastases	Right ureteral stent placement and left ureteral stent removal	Distal right ureter, bladder, sciatic nerve roots, colon	Left leg weakness, decreased ankle dorso and plantar flexion, decreased leg raise, left leg parasthesias, Contained Colon Perforation	On discharge she had partial resolution of left leg weakness and paresthesias. Foot drop and was at baseline prior to IRE procedure. Discharged with rolling walker for ambulation	18 months; 5/2021 Exploratory Laparotomy	None	31 months from 1st IRE; Alive; 12/13/21 MRI
3	1st IRE	5/20/19	57 M	Rectal Cancer	Chemoradiation with xeloda, perineal resection with end colostomy, FOLFOX	2.4 x 1.7 cm Left presacral metastasis	FOLFOX prior to IRE	Bladder, sacral nerve roots, bowel, rectum	No complications	N/A	None at 23 months; 4/20/21 CT	None	25 months; Alive; 6/23/21 Office Visit

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Acknowledgements

I would like to acknowledge the mentorship of Dr. Michael Savin M.D. and Jeffrey Savin M.D. Also, the help of Brett Friedman M.P.H. for preliminary work on the project.