Widening the Therapeutic Window using an Implantable, Uni-directional LDR Brachytherapy Sheet as a Boost in Pancreatic Cancer

Shannon S. Yoo[1], Dorin A. Todor[2], Jennifer M. Myers[3], Brian J. Kaplan[4],Emma C. Fields, MD[2]

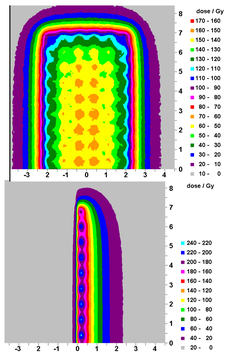
Virginia Commonwealth University, Richmond, VA [1]School of Medicine [2]Department of Radiation Oncology [3]Department of Internal Medicine [4]Department of Surgery

PURPOSE

- Patients with borderline resectable pancreatic cancer are typically treated with neoadjuvant therapy including chemotherapy followed by chemoradiation with the goal of becoming surgical candidates.
- Unfortunately, due to inflammatory changes after treatment the pre-operative imaging is not reliable in determining resectability and many patients still have concern for close or positive retroperitoneal margins given the proximity to major vasculature.
- Post-operatively, an external beam RT (EBRT) boost is difficult given bowel constraints and difficulty in identifying the area at highest risk.
- The purpose of this study is to demonstrate the ability of the LDR brachytherapy CivaSheet to deliver a focal high-dose boost, targeted to the area at highest risk in patients who received neoadjuvant chemoradiation.

MATERIALS & METHODS

- 4 patients with borderline resectable pancreatic cancer received neoadjuvant FOLFIRINOX followed by gemcitabine-based chemoRT to 50.4Gy in 28 fractions with dose prescribed to the gross tumor plus a 1cm margin.
- After neoadjuvant therapy, the multidisciplinary team was concerned for close or positive margin resection.



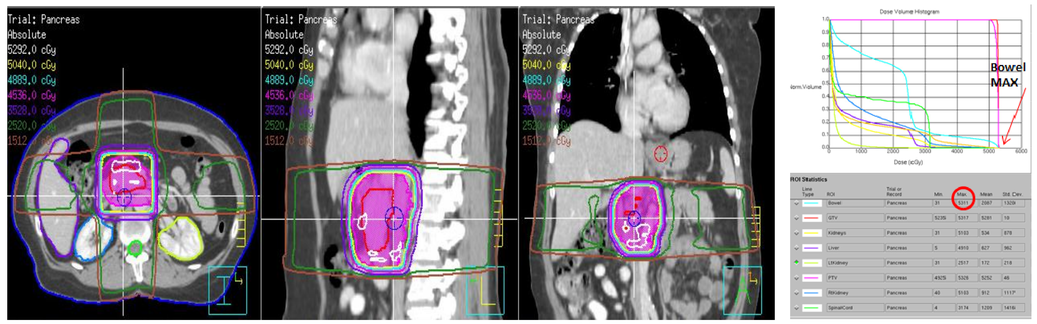
CivaSheet® is an FDA-cleared product from CivaTech Oncology® consisting of a matrix of uni-directional Pd-103 radiation sources on a bio-absorbable membrane. 38Gy EQD2 dose to 5mm depth is prescribed in these patients and therefore delivers a total dose of 88.4Gy to the targeted tissue.

- Post-operatively, patients had a CT scan. The tumor bed and organs at risk were contoured.
- Small bowel (SB) was contoured as the bowel bag and included the entire peritoneal cavity.
- Brachytherapy plans as well as EBRT boost plans were created for each patient.

RESULTS

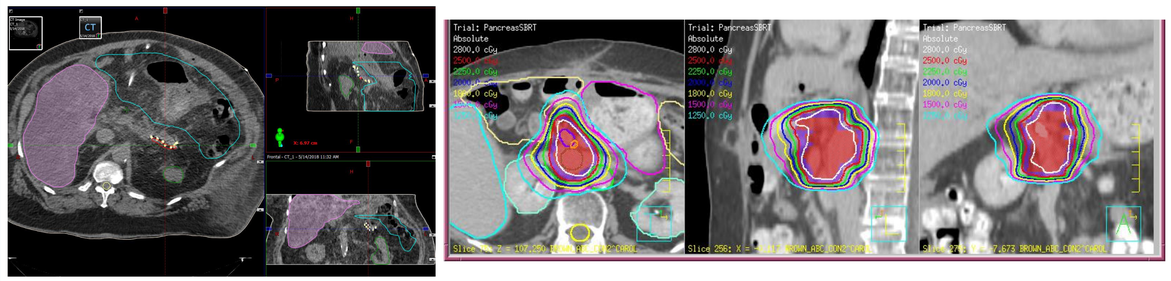
- DVH from initial 3D treatment plans for all patients showed the SB volume receiving 45Gy (V45) was a median of 78.2cc (range 61.7-107.1ccs) and maximum bowel doses were a median of 53.2, range 53.1-53.6Gy.

Representative 3D plan and DVH for initial pre-operative treatment



- Per Quantec and current pancreatic protocols (REF), the V45 for SB should be <195cc with a max of ≤58Gy to prevent SB obstruction, fistula and perforation[1,2].
- With these fixed constraints we were left with about an additional 5-10Gy boost possible with EBRT.
- With the sheet, the boost dose can be dramatically increased and the dose to the SB was marginal at about 1/10th of the prescription dose. For the target, the brachytherapy sheet delivers prescription dose to 5mm depth with a large inhomogeneous dose throughout the tumor bed with the minimum dose of 38Gy.

Visual Comparison of a CivaSheet Tumor Bed Boost (left) and an SBRT Tumor Bed Boost (right)



Dosimetric Comparison of a CivaSheet Tumor Bed Boost and an SBRT Tumor Bed Boost

Structure	Civa Sheet Plan	External Beam Plan
CTV	25Gy	25Gy
Small Bowel (Max)	**9.6Gy**	**24Gy**
Kidneys (Mean)	0.5Gy	6.6Gy
Liver (Mean)	0Gy	2.4Gy
Cord (Max)	0Gy	4.4Gy

SUMMARY & CONCLUSIONS

- These are the first patients in the world to be treated with the LDR implantable brachytherapy sheet at the time of surgery as a boost for pancreatic cancer after neoadjuvant therapy.
- This dosimetric study shows that applying this uni-directional source to the area at highest risk can serve to improve the therapeutic index by improving the local control and minimizing toxicities in this deadly disease.
- The possibilities for use in other disease sites is vast – other uses include for pelvic re-irradiation in colorectal or gyn cancers, sarcomas, skin lesions, axillary disease, etc.

Informal presentation from the American Brachytherapy Society Meeting in San Francisco, June 2018 describing all of the cases of CivaSheet done at VCU

REFERENCES

1. Kavanagh BD, Pan CC, Dawson LA, et al. Radiation dose-volume effects in the stomach and small bowel. Int J Radiat Oncol Biol Phys: 2010; 76(3).
2. RTOG 1201 A Phase II Randomized Trial of High Versus Standard Intensity Local or Systemic Therapy for Unresectable Pancreatic Cancer. Version 11/3/2014.

Contact information emma.fields@vcuhealth.org (email) (804) 828-7232 (phone)