Cureus

Technical Challenges with Electrophysiology-based Cardiac SBRT for Treating Patients with Refractory Ventricular Tachycardia: A Feasibility Study

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Abstract
Published 02/11/2022

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Categories: Radiation Oncology
Keywords: refractory ventricular tachycardia, cardiac sbrt, cardioablation

How to cite this abstract
Taremi M, Khaykin Y, Comsa D, et al. (February 11, 2022) Technical Challenges with Electrophysiology-based Cardiac SBRT for Treating Patients with Refractory Ventricular Tachycardia: A Feasibility Study. Cureus 14(2): a768

Abstract

Objective: 1. To review the process and protocol of two otherwise standard procedures used in Cardiology (Multi lead surface ECG mapping) and the Radiation Medicine Department with the scope of ablating VT (ventricular tachycardia) in patients who have failed or were deemed ineligible for traditional ablation.
2. To report the technical challenges regarding patients care, target delineation and technique delivery using cardiac SBRT.

Methods: A treatment protocol was developed and approved by the hospital REB. Patients with drug refractory VT were approached by the electro-physiology (EP) department coordinator to participate in the study. If eligible, a CT scan was obtained with the patients wearing a single-use ECGI vest (Cardio Insight, Medtronic) containing 252 electrodes. For identification of the VT substrate patients underwent a standard VT induction procedure in the HRIS (heart rhythm interventional suite) lab using their ICD or a percutaneously placed catheter. A few days later, a 4D-CT simulation scan was acquired with the patient in treatment position supine with arms up above the head, using an adjustable arm support. This dataset allowed subsequent contouring of the VT target and radiation planning. Clinical target volume was delineated by the radiation oncologist and cardiologist using ECGI mapping information and anatomic landmarks. A treatment plan with the prescription dose of 25 Gy in a single fraction was created to meet criteria of the study protocol, using a VMAT (volumetric modulated arc therapy) technique with 2 arcs. VT targets and plans were reviewed by an expert group at the Center for Noninvasive Cardiac Radioablation (CNCR), Washington University, prior to the treatment. On treatment day, patients were seen by the EP and rad/onc, and a clinical exam was performed with the documentation of the clinical data. All patients were followed closely and side effects were documented as per protocol requirements.

Results: To our knowledge, this is one of the first Canadian inter-disciplinary REB-approved VT-SBRT treatment protocol. While the body of evidence for VT-SABR is growing fast, with a few multi-institutional protocols already announced, clinical reports are still scarce. We are contributing planning, treatment and follow up data for three patients with follow up between 6-12 months. The study was initiated in the fall of 2020; between October 2020 to September 2021, 7 patients were referred by the cardiology team, of which 3 patients have been successfully enrolled in the study and treated so far. Two patients were not eligible including 1- patient with the simultaneous diagnosis of mediastinal adenopathies biopsy proven lymphoma 2- patient with a ventricular storm and VT that were seemed to be under control with the medical management. Patient# 6 and #7 have been assessed, deemed eligible for treatment and currently starting the treatment planning process.

A number of challenging patient-related factors, which typically fall outside of a treatment protocol, were identified and are worth discussing, as their management required detailed discussion and communication among the treating teams. They were as follows: for patient # 1 - patient's weight exceeded the treatment machine capacity. This patient also had difficulty in tolerating the treatment position due to severe bowel issues, had difficult mobility and transfer from chair to bed due to severe cellulitis. For patient # 2: problem with maintaining the vitals stable and radiotherapy scheduling in respect to daily dialysis. For patient # 3, mediastinal adenopathy NYD that could not be biopsied due to the patient being at high risk for any surgical procedures and for contrast enhanced imaging (kidney failure). Treatment planning factors included: Patient # 1: a large portion of the bowels was in the chest and adjacent to the target due to a large hernia; this patient had very irregular breathing pattern on the 4D CT scan images. Patient #2: Stomach adjacent to the target volume and finally, Patient # 3 presented a multifocal target.

Unforeseeable challenges at the start of a new stereotactic treatment method are discussed. Sustained team

communication and collaboration with a group of world experts are essential for successful treatment.

Conclusion: In patients with drug refractory ventricular tachycardia, ECGI-guided stereotactic VT radiation ablation was a feasible approach which reduced the burden of VT episodes with acceptable toxicity profile. However this group of patients and targets carry a different spectrum of issues for the radiation oncology team which require interdisciplinary approach.