Cardiac Dose and Survival Following Stereotactic Body Radiotherapy for Early Stage Non-Small Cell Lung Cancer

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Purpose/Objectives

Stereotactic body radiotherapy (SBRT) is a standard therapy for early stage, medically inoperable non-small cell lung cancer (NSCLC). Recent analyses identify cardiac dose as an important predictor of overall survival (OS) following chemoradiation for locally advanced NSCLC. However, the influence of cardiac dose on OS following SBRT is unknown.

The cardiac dosimetry of SBRT is markedly different than typically found in stage III disease, with the potential for small volumes of heart to receive high biologic effective doses (BED).

We performed a detailed dose volume histogram (DVH) analysis on a large cohort of early stage NSCLC patients treated with to examine the influence of cardiac dose on OS.

Methods

We reviewed the charts of all patients treated at our institution with SBRT for early stage NSCLC between 6/2007-6/2015 with a retrievable DVH and a minimum follow-up of six months or until death.

Cardiac contours were reviewed and revised in accordance with the RTOG contouring atlas. Cardiac DVH parameters including max and mean dose, V5, V10, V20, and V30 were documented. Rigid registration was used to generate a DVH for patients with multiple treatments.

OS was assessed with the Kaplan Meier method. To account for fractionation, we converted all max and mean cardiac doses to biologically effective dose (BED) assuming an α/β ratio of 2 for the heart, and a conversion to equivalent dose in 2 Gy fractions (EQD2/2) using the LQ model. Both unconverted and converted values were analyzed.

The influence of each cardiac DVH parameter on survival was assessed using a Cox regression model, with radiation dose as a continuous variable.

Results

Table 1: Patient and Treatment Characteristics

Characteristic	Value (% or range)
Median age	76.2(48.9 – 93.1)
Female	56 (54.9%)
Ever smoker?	74 (72.5%)
2 Year OS	70.4 %
Histology	
Adenocarcinoma	62(52.5%)
Squamous cell carcinoma	32 (27.1%)
Unbiopsied	17 (14.4%)
Other*	7(5.9%)
T-stage	
IA	69 (58.5%)
IB	27 (22.9%)
IIA	18 (15.3%)
IIB	4 (3.4%)
Prescribed dose	
54 Gy in 3 fractions	23 (19.5%)
50 Gy in 4 fractions	32 (27.1%)
50 Gy in 5 fractions	28 (23.7%)
Other	35 (29.7%)

DVH Parameters

Nine patients (8.8%) had a cardiac max dose >50 Gy. 3 patients (2.9%) had a mean cardiac dose exceeding 10 Gy. DVH statistics including with doses converted to BED2 and EQD2/2 are shown in Table 2.

Overall Survival

No statistically significant correlation between OS and any evaluated cardiac dose parameter was identified (p>0.05)

Cardiac Toxicity

No acute cardiac toxicity was identified in any patient. Four patients (3.9%) died of cardiac causes (congestive heart failure in 3 patients and cardiac arrest in one) during the follow-up period, all with pre-existing cardiac disease. Three of the 4 had DVH parameters below the median for the cohort. Cause of death was unavailable for 8 patients.

Table 2: Cardiac dose-volume parameters

	V5	V20	Max point BED	Mean BED	Max dose EQD2/2	Mean dose EQD2/2
Median (range)	V5: 8.7% (0-96.4%	0 (0-17.0%)	37.2 Gy_2 (0.4-682.8 Gy_2)	1.1 Gy_2 (0-12.6 Gy_2)	18.6 $Gy_{2/2}$ (0.2-341.4 $Gy_{2/2}$)	0.5 $Gy_{2/2}$ (0-10.8 $Gy_{2/2}$)

Abbreviations: BED = Biologic Equivalent Dose; EQD2/2 = equivalent dose in 2 Gy fractions

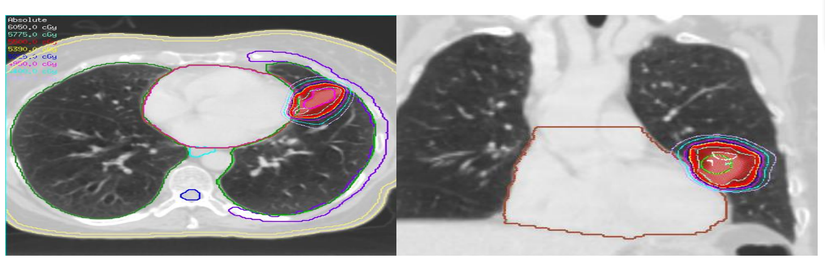

Figure 1: Example patient treated with SBRT to 55 Gy in 5 fractions for T1bN0M0 adenocarcinoma of the lingula. DVH revealed a point max 60.44 Gy. Mean cardiac dose 8.3 Gy. No cardiac toxicity at 32 months follow up.

Conclusions

High RT doses to small volumes of heart appears relatively safe in the medically inoperable population treated with SBRT for NSCLC.

Our analyses did not identify a cardiac DVH parameter that predicted survival following SBRT.

Our current approach of limiting point max doses to <105% of the prescription dose and volumetric constraints to “as low as reasonably achievable” does not appear to result in an excess of early cardiac toxicity