



Purpose

To evaluate radiation dose to out of field pacemakers in head and neck IMRT. Maximum doses were calculated by the treatment planning systems (TPS) and compared to measurements taken by *in vivo* optically stimulated luminescence dosimeters (OSLDs)

Methods

Five patients with squamous cell carcinoma of the head and neck were treated with IMRT with a pacemaker device located in their left superior chest

- All pacemakers were located near but outside of the planned radiation treatment volume
- Each patient was treated to 70 Gy in 35 fractions to the primary tumor with bilateral cervical neck nodal volumes, including left level IV (56 – 63 Gy)
- The pacemaker volume was contoured in the TPS covering the device but not including the wires from the device into the atrium or ventricles
- Both Tomotherapy™ (TOMO) and linear accelerator (LINAC) based IMRT plans were developed for 4 of 5 patients. Eclipse™ TPS was used for all patients except for patient 5 (Pinnacle™). Patients 1-4 were treated with TOMO

•TPS dose constraint: pacemaker maximum dose < 5 Gy

•OSLDs were placed on the skin over the pacemaker with a lead shield and 5mm bolus between skin and shield

•OSLDs measurements included dose from image guidance: cone-beam computed tomography or mega-voltage computed tomography

•Maximum dose measured by *in vivo* dosimetry was compared to the maximum dose calculated by the TPS

Methods

In Vivo Dosimeter Setup



Left Image: OSLDs are numbered and placed over pacemaker

Right Image: OSLDs covered with 5mm of bolus and a lead shield. The lead shield and bolus are used for all fractions of treatment

Results

Patient	TOMO TPS Calculated Maximum Dose (Gy)	LINAC TPS Calculated Maximum dose (Gy)	OSLDs Measured Maximum Dose (Gy)	OSLD Measured Dose to TPS Calculated Ratio
1	3.58	7.1	4.57 (TOMO)	128 %
2	1.54	1.76	2.2 (TOMO)	143 %
3	2.25	4.72	3.2 (TOMO)	142 %
4	1.79	3.6	3.12 (TOMO)	174 %
5	LINAC only	2.23	4.55 (LINAC)	204 %

Table 1. Maximum dose results as calculated by TPS and measured by OSLD. For patient 1 - 4: treatment plans were created on Eclipse and Tomotherapy™ TPS. Patient 5 was calculated using Pinnacle™ treatment planning system and treated on a LINAC, a TOMO plan was not created for this patient. OSLD measurements were only taken on respective treatment machine, labeled TOMO or LINAC in parenthesis

Conclusion / Discussion

- TPS calculations consistently underestimate radiation dose to pacemakers when compared with measurements obtained using *in vivo* OSLDs
- Variation is observed between different planning systems when calculating maximum pacemaker dose reflecting the challenge of accurate out of field dosimetry
- We recommend performing *in vivo* dosimetry to better ensure manufacturer pacemaker dose recommendations are not exceeded