

Planning Protocol		EORTC	Institutional	RTOG
Median POP		120	150	190
Mean PTV Dose (Gy)		71.4 ± 0.1	71.7 ± 0.2	72.6 ± 0.4
Mean Dose (Gy)	Contralateral Parotid	18.4 ± 6.1	20.9 ± 6.8	25.4 ± 8.7
	Ipsilateral Parotid	24.2 ± 6.2	26.9 ± 6.5	31.8 ± 8.2
	Contralateral Submandibular	31.4 ± 5.0	33.8 ± 5.3	38.6 ± 7.9
	Composite Salivary Structures	24.3 ± 8.2	27.0 ± 9.2	31.6 ± 10.3
	Composite Swallowing Structures	22.9 ± 4.2	25.7 ± 5.2	29.5 ± 4.2
	OARcomp Dose (Gy)	24.0 ± 4.5	26.3 ± 5.0	30.6 ± 5.2

Conclusions: OAR doses are significantly influenced by the choice of planning protocol. Planning according to the EORTC protocol could reduce OAR dose by up to 28% compared to the RTOG protocol, at the cost of a larger PTV dose inhomogeneity. When interpreting study results or evaluating technologies that aim to lower OAR doses (such as VMAT), knowledge of planning protocols is necessary. In addition, future implementation of model or library-based automatic planning solutions and protocol sharing between institutions will require users to be familiar with the underlying planning trade-offs on which these solutions are based.

This work was funded by Varian Medical Systems.

PD-0412

Combined FiF+ Tangent-to-tangents VMAT breast SIB technique: Clinical introduction of an optimal class solution

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Purpose/Objective: To develop a robust treatment planning approach for hypofractionated whole breast irradiation with highly conformal simultaneously integrated boost (SIB) in supine position.

Materials and Methods: Fifteen unselected patients were included this study (10 planned and 5 treated with SIB) using Pinnacle 9.0 (Philips, Best, NL). For the breast (PTV1) irradiation two tangential field-in-field beams were used. For treating the boost (PTV2) volume with classical approach (CLA) two individually determined gantry angles were used while for SIB a single VMAT beam starting at one tangent and stopping at the other were created (Tangent-to-tangent 'T2T' VMAT with 180° arc) using an isocenter suitable for regional lymph node irradiation. SIB was optimized using inverse SmartARC technique taking into account the dose contribution of the initial breast tangents. For adequate comparison both plans were normalized for 45.57 Gy and 55.86 Gy mean dose for PTV1 and PTV2 in 21 fractions (2.17 and 2.66Gy/fr). Ipsilateral lung, heart, contralateral breast were contoured as OARs. The following DVH parameters were used for comparison: V48.76Gy (107% of breast prescription dose) for PTV1 and PTV1-2 (PTV1 excluding the PTV2 volume), V53.06Gy (95% of boost prescription) for PTV1-2 and PTV2, and V59.76Gy for PTV2 (107% of the boost prescription). For the ipsilateral lung V20, V30, for the heart V10, Dmean, D2 and for the contralateral breast Dmean and D2 were compared using two tailed t-test with the significance level p<0.05.

Results: The PTV1 and PTV2 ranged between 332-2466 cm³ and 30-377 cm³, while the PTV2/PTV1 ratio varied between 7-25%. Our dosimetrical findings are summarized in Figure 1. The FiF+T2T-VMAT SIB technique showed statistically significant improvement (SIB vs. CLA) for PTV1-2_48.76 (28.5 vs. 40.0%), PTV1-2_53.06 (6.6 vs. 22.5%), PTV1_53.06 (18.3 vs. 32.3%) with p<0.001 and for PTV2_53.06 (99.4 vs. 98%) with p=0.04 compared to CLA, while for PTV2_59.76 no difference was found (1.0 vs. 1.7%, p=0.6). For OARs no significant changes were observed between the two techniques: for lung V20 (10.0 vs. 11.12%) and V30 (8.0 vs. 9.0%), for heart V10 (2.5 vs. 2.6%), Dmean (2.9 vs. 2.7 Gy) and D2 (18.0 vs. 19.2 Gy), for contralateral breast Dmean (1.0 vs. 1.0 Gy), and D2 (5.0 vs. 4.5 Gy). Based on the CLA and SIB approaches 5/15 and 14/15 patients met the Import High trial's SIB constraints (e.g. <5% of PTV1-2 receives the boost prescription dose).

Conclusions: The T2T-VMAT technique is an excellent class solution for breast SIB in supine position (for any breast sizes and tumor localization.) The guaranteed high boost coverage and conformity combined with the most idle gantry rotation even with regional lymph node irradiation makes this technique attractive for daily routine.

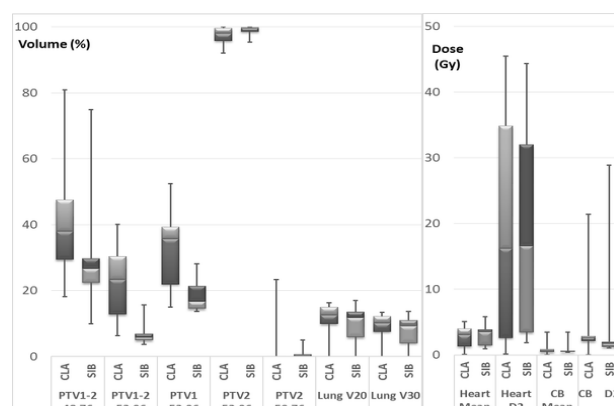


Figure 1. Comparison of classical (CLA) and SIB treatment planning for breast cancer patients with Field-in-Field and Tangent-to-Tangents VMAT (FiF+T2T-VMAT SIB).

PD-0413

Calculation of microdosimetric data due to subcellular compartment sizes determined from histological samples

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Purpose/Objective: In this study we examine dose variation to different cell compartments due to variations in morphology and related chemical composition of the irradiated tissue. The size of cell and nuclei are dependent on tissue type, cell cycle, malignancy and varies between different patients. To date there has been a lack of robust, quantitative models describing the tumour/healthy tissue cells/nucleus and the extra cellular matrix. For accurate determination of evidence based links between macroscopic physical beam properties and clinically observed radiation response, it is important to also quantitatively know microdosimetry properties due to variations in cellular morphology.

Materials and Methods: Cell and nuclei size distributions are derived from histology samples for use as input in Monte Carlo (MC) based calculations of energy absorptions. Stained and unstained regions of the histology samples are segmented using a Gaussian mixture model and individual cell nuclei are identified via thresholding. Delaunay triangulation is applied to determine the distribution of distances between the centroids of nearest neighbours (Figure 1a). A pouring simulation is used to build a 3D virtual tissue sample, with cell radii randomized according to the cell size distribution measured from the histology (Figure 1b). A slice with the same thickness as the histology sample is cut through the 3D data and characterized in the same way as the measured histology. The comparison between this virtual slice and the measured histology is used to adjust the initial cell size distribution into the pouring simulation (Figure 1c). The thus obtained, morphologically realistic, 3D cellular geometries are loaded into our Geant4 based MC program for calculation of specific energy absorptions to different cell compartments. The geometry is placed inside a larger water filled sphere of sufficient size to ensure charged particle equilibrium. Data are derived for mono-energetic photons with energies ranging from 20 keV up to 1.25 MeV.

