Evaluation of VMAT and FFF-VMAT Treatment Plans for Left-Sided DIBH Patients

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Introduction

In recent years, Deep Inspiration Breath Hold (DIBH) has become a popular treatment for left-sided breast cancer patients. There are a variety of methods that are used for treating with DIBH including Volumetric Modulated Arc Therapy (VMAT) and Flattening Filter Free (FFF) arcs. However, there haven't been many studies comparing the differences between VMAT and FFF-VMAT. The objective of this study was to dosimetrically compare VMAT and FFF-VMAT plans in left sided breast cancer patients of varying physical characteristics to see if dosimetric differences exist between these two plans.

Materials and Methods

Six (n=6) breast cancer patients with varying physical characteristics were retrospectively planned using Monaco TPS. For each patient, a plan with two 6MV arcs and one with two 6MV FFF arcs were planned according to the NRG 1005 protocol guidelines. Both the VMAT and FFF-VMAT plans prescribed a dose of 50 Gy in 25 fractions to the PTV and both plans were normalized to so that at least 90% of the PTV volume received 90% of the prescribed dose. For each plan the dose to the organ at risk (OAR) parameters for the lungs, heart, and contralateral breast, were evaluated. Furthermore, the treatment delivery time was measured by delivering the plans to an empty vault. Statistical differences were evaluated with paired t-test and a significance level of $p < 0.05$.

Results

There were no statistically significant differences in the PTV coverage, mean doses and maximum doses to OARS, or treatment delivery times. A statistically significant difference ($p<0.05$) was found between the average number of monitor units for the VMAT (913MU) and VMAT FFF (1187MU) respectively.

Conclusion

This study investigated whether dosimetric differences between FFF and VMAT FFF exist. As demonstrated with P values, the only statistically significant difference was observed on the number of monitor units between VMAT and FFF. Both VMAT and VMAT FFF achieved the same PTV coverage and similar doses to OAR.

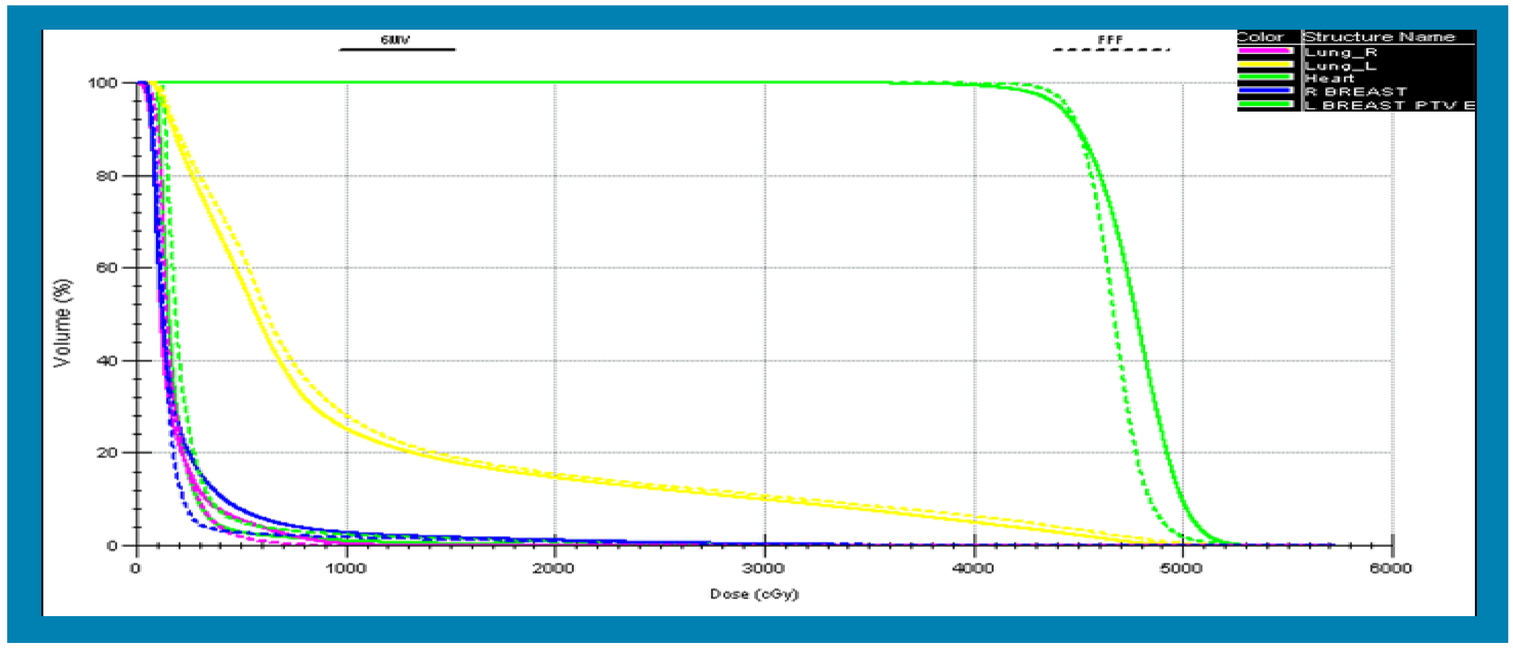

Figure 1: *Dose volume histogram (cGy) – for sample patient displays similar coverage to the PTV and shows minor differences in OARs between VMAT And FFF.*

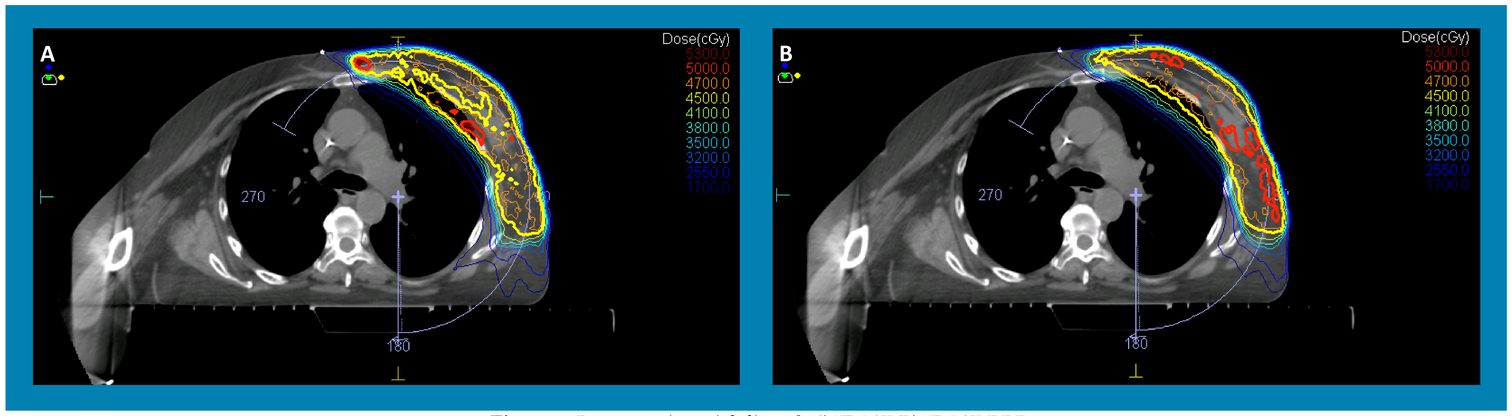

Figure 2: *Representative axial slices of A) VMAT B) VMAT-FFF.*

Patient Number	Mean Heart Dose (cGy)		Max Heart Dose (cGy)		Mean Dose to left Lung (cGy)	
	VMAT	FFF	VMAT	FFF	VMAT	FFF
1	290	365	2604	3713	1001	1398
2	448	427	3078	3077	1385	1411
3	390	348	4059	4511	1044	939
4	358	427	1850	3996	1430	1512
5	304	438	2756	2537	1366	1146
6	187	498	1318	3619	833	1105
p-value	0.15269		0.07965		0.45869	

Table 1: *VMAT vs FFF – Comparison of mean and max dose to OARs.*

Patient Number	Treatment Time (seconds)		Monitor units	
	VMAT	FFF	VMAT	FFF
1	255	260	836	1133
2	258	346	1053	1569
3	222	245	978	978
4	265	270	961	1190
5	153	206	735	1064
6	214	219	893	945
p-value	0.09429728		0.028252	

Table 2: *VMAT vs FFF – Comparison of Treatment time and Monitor units*

Patient Number	V5 to contralateral breast (cGy)		V20 left lung (cGy)		V5 left Lung (cGy)	
	VMAT	FFF	VMAT	FFF	VMAT	FFF
1	7.70%	4.23%	14.62%	22.59%	57%	76%
2	8.35%	8.48%	24.28%	22.08%	69%	72.30%
3	6.39%	6.55%	16.50%	16.26%	58%	40.60%
4	7.25%	5.73%	26.28%	26.40%	65%	76.49%
5	8.27%	9.21%	26.16%	22%	62%	45.94%
6	8.25%	8.69%	12.65%	19.55%	41%	51%
p-value	0.36080		0.48817		0.81501	

Table 3.: *VMAT vs FFF – Comparison of volumetric dose to OARs.*