

Introduction

Over the past few years, due to growing concerns for cardiac toxicity with traditional free breathing techniques, there has been an increase in the use of respiratory management techniques such as deep-inspiration breath hold (DIBH) in the treatment of left-sided breast cancers. There has also been an increased use of Volumetric Modulated Arc Therapy (VMAT) for DIBH, but the optimal planning technique has yet to be determined. The purpose of this study is to evaluate the clinical practicality and dosimetric differences between two vs three arc VMAT-DIBH breast plans.

Materials and Methods

Six (n=6) patients previously treated to the left breast with DIBH were planned in the Pinnacle3 TPS using double and triple beam SmartArc plans. All patients were optimized with the same beam configurations and normalized to receive 50 Gy in 25 fractions. Contours were created and approved by a radiation oncologist. Each plan was independently evaluated for its clinical acceptability by both a physician and a physicist. Comparative endpoints were evaluated using the RTOG 1304 (NSABP B-51) protocol with the target coverage, conformity, dose to organs at risk (OARs), treatment time and the number of plan optimizations being evaluated. These treatments were delivered in an empty vault and timed. Then, a patient delivery time was estimated based on average patient breath hold and recovery times. Paired t-tests were performed to evaluate the statistical significance of the endpoint differences.

Results

As seen in Table 1, there were no statistically significant differences in the PTV conformity index (95% isodose line to 100% PTV volume), the mean doses to OARs, volumetric constraints for OARs, max point doses, or number of optimizations. For the total treatment time a statistically significant difference ($p < 0.01$) was found with the average total delivery time of 235.5 seconds and 299.5 seconds for the two and three arc plans, respectively (shown in Table 3).

Conclusion

This study evaluated the clinical practicality and dosimetric differences between treating patients with left-sided breast cancer using VMAT-DIBH with two vs three arcs; represented in a DVH in Fig. 1. Delivery of the two arc plans was shorter when compared to the three arc plans and achieved similar PTV coverage and OAR sparing. Planning patients with left-sided breast cancer using two arc VMAT-DIBH has the potential to shorten delivery time and improve patient comfort without compromising clinical outcomes.

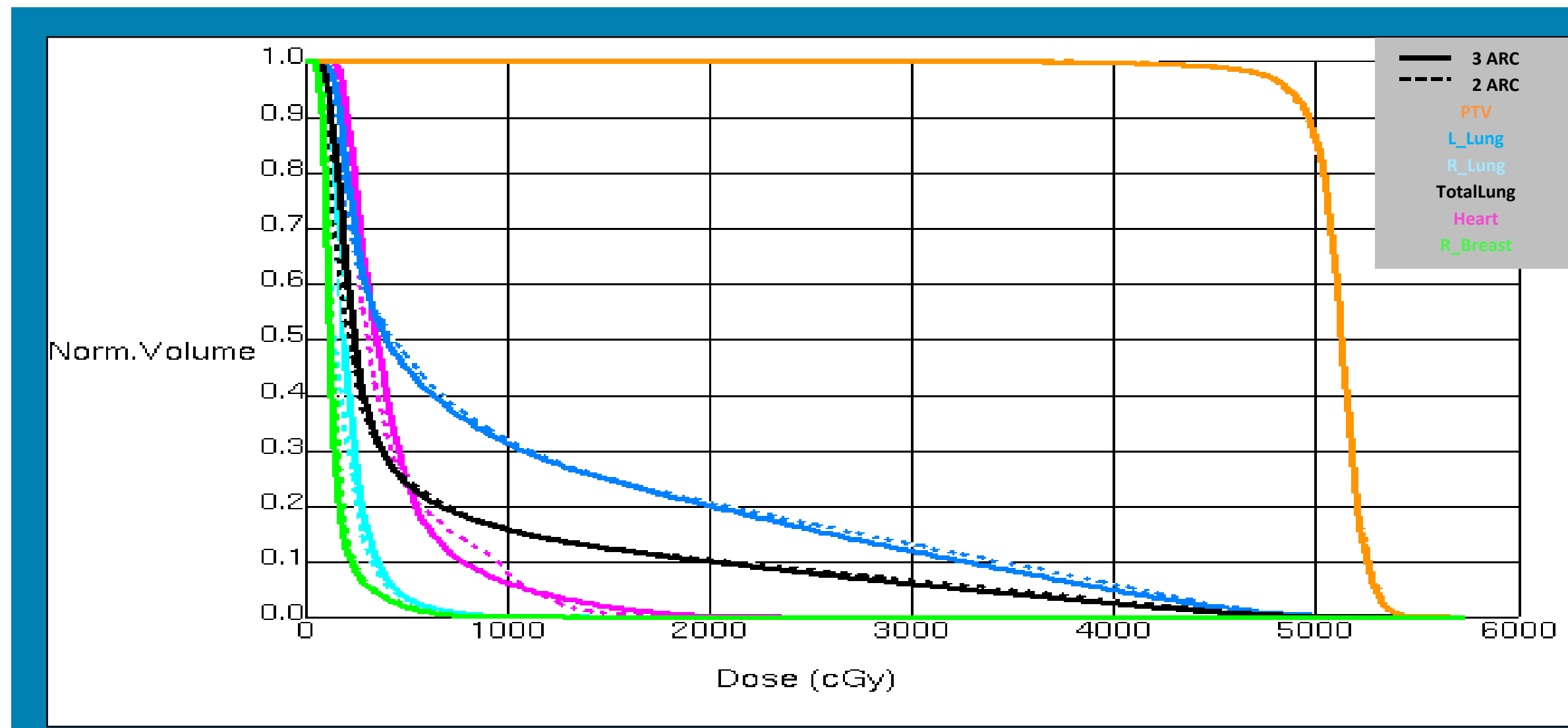


Figure 1: Dose volume histogram (cGy) – cumulative, absolute DVH for sample patient shows comparable coverage to the PTV and shows minor differences in OAR.

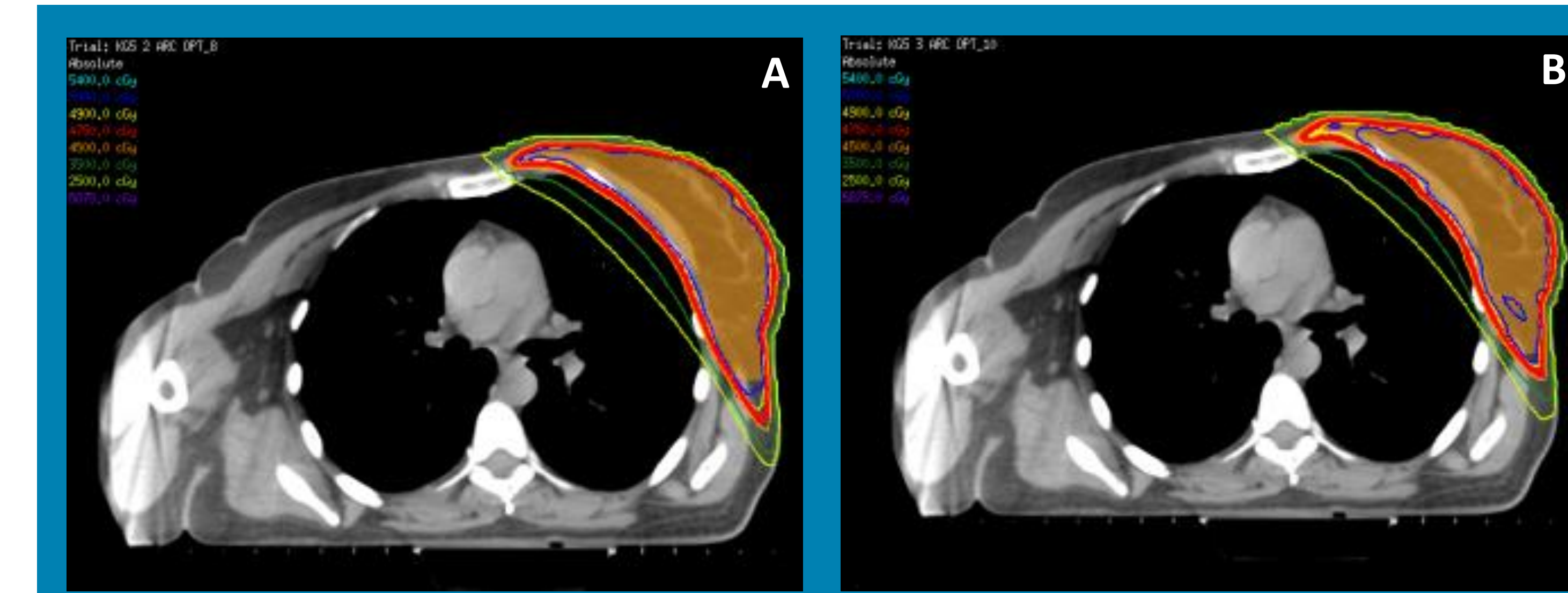


Figure 2: 2D dose representation for plans A) VMAT 2 Arcs and B) VMAT 3 Arcs depicting isodose coverage on a representative anatomical section.

Patient Number	Total Lung Mean Dose (cGy)		Mean Heart Dose (cGy)		Contralateral Breast Mean Dose (cGy)		Maximum point dose at 0.1cc (cGy)		Contralateral Breast Max Dose (cGy)	
	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc
1	572	552	441	441	235	232	5562	5591	3447	3172
2	704	687	459	430	259	234	5799	5677	3332	2560
3	770	715	491	482	182	197	5521	5483	2458	2475
4	637	642	425	442	164	150	5474	5611	1366	1288
5	834	850	445	413	162	167	5629	5589	774	952
6	580	541	371	328	165	147	5579	5578	2113	1897
P VALUE	0.14		0.15		0.30		0.88		0.21	

Table 1: Comparison between two and three arc VMAT DIBH breast TX plans evaluating mean and max dose to OARs.

Patient #	Heart-V ₃₀		Lung_L-V ₂₀		R Breast-V ₅		Lung_L-V ₁₀		Lung_L-V ₅		Lung_R-V ₅	
	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc
1	0.14%	0.16%	18.72%	18.47%	6.66%	7.67%	31.63%	30.82%	46.91%	44.53%	2.93%	2.30%
2	0.17%	0.00%	22.67%	22.52%	7.07%	6.13%	38.63%	37.27%	55.37%	52.70%	6.04%	3.66%
3	0.10%	0.00%	26.02%	24.07%	4.83%	7.47%	38.15%	47.28%	54.82%	64.92%	6.85%	0.82%
4	0.00%	0.00%	20.53%	19.95%	2.22%	1.93%	31.76%	31.24%	47.02%	44.81%	2.98%	3.58%
5	0.88%	0.00%	27.82%	28.03%	9.32%	9.64%	40.22%	43.18%	54.99%	61.40%	13.91%	11.73%
6	0.11%	0.00%	21.35%	19.58%	5.30%	3.60%	32.90%	32.41%	50.42%	47.79%	0.01%	0.50%
P VALUE	0.19		0.10		0.79		0.41		0.65		0.16	

Table 2: Comparison between two and three arc VMAT DIBH breast TX plans evaluating volumetric dose to OARs.

Patient Number	Conformity Index		Number of Optimizations		Treatment Time (seconds)			
	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc	2 Arc	3 Arc
1	0.96	0.95	17.00	9.00	144.97	241.62	178.37	297.28
2	0.96	0.96	17.00	10.00	144.28	240.47	188.05	313.42
3	0.97	0.97	7.00	15.00	140.89	234.82	190.25	317.08
4	0.97	0.97	8.00	10.00	133.63	222.72	172.60	287.67
5	0.95	0.95	14.00	12.00	125.18	208.63	163.78	272.97
6	0.99	0.99	10.00	9.00	158.97	264.95	185.22	308.70
P VALUE	0.43		0.61		<0.01		<0.01	

Table 3: Comparison between two and three arc VMAT DIBH breast TX plans evaluating clinical practicality.