



# Dosimetric Comparison of Hybrid Plan, 3DCRT and VMAT in Patients with Left-sided Breast Cancer

Sohyun Ahn<sup>1</sup>, Eunbin Ju<sup>1,2</sup>, Nuri Hyun Jung<sup>1</sup>, Yeonju Kim<sup>3</sup>

<sup>1</sup>Department of Radiation Oncology, Kangwon National University Hospital, Chuncheon-si, Republic of Korea,

<sup>2</sup>Department of Bio-medical Science, Graduate School of Korea University, Sejong, Republic of Korea,

<sup>3</sup>Department of Radiation Oncology, Asan Medical Center, Seoul, Republic of Korea



## INTRODUCTION

Because of the anatomical characteristic of breast, the 3-dimensional treatment using tangential beams is widely used despite the fact that IMRT or VMAT is the most preferred treatment in other sites<sup>1-5,7-8</sup>. When using IMRT or VMAT for breast cancer, the low dose of the lung increases, but the superiority of target coverage does not increase significantly. However 3-dimensional treatment using tangential beams is likely to deliver high doses to the heart, which is a concern for late cardiac toxicities. As a result of 10-year long term follow up after breast radiotherapy, late cardiac toxicities were observed in patients with left-sided breast cancer. Late cardiac toxicities are not limited to the mean dose of the heart, but may also be attributed to the high dose received by the subvolume of heart, particularly apical regions such as left ventricle (LV) and left anterior descending artery (LAD)<sup>6</sup>. Considering this aspect, our institution treated patients with left breast cancer by hybrid breast treatment combining VMAT and 3-dimensional treatment in 2019.

## AIM

The purpose of this study is to evaluate the radiation treatment plan quality in the hybrid volumetric modulated arc therapy by comparing it with the volumetric modulated arc therapy (VMAT) and three-dimensional conformal radiation therapy (3DCRT).

## METHOD

A total of 19 left-sided breast cancer patients who were treated with a hybrid plan were included in this study. A hybrid plan was created by combining the VMAT and 3DCRT plans at a rate of 30% and 70%, respectively. The prescription dose was 260 cGy in 16 fractions. To compare the plan quality,  $V_{5Gy}$ ,  $V_{20Gy}$ ,  $V_{30Gy}$ ,  $D_{max}$ , and  $D_{mean}$  were calculated for contralateral lung, ipsilateral lung, and heart. In the case of PTV,  $D_{max}$ ,  $D_{mean}$ , and  $V_{95\%}$  were evaluated. In order to verify the effect of the anatomical characteristics of heart on the heart dose. How close the heart is to the breast is different for each patient. In order to confirm this quantitatively, a straight line connecting the median center and the lateral marker of the breast was drawn in the CT image, and the maximum orthogonal length of the heart included closer to the breast than the straight line was measured. The heart dose according to the orthogonal length was compared.

## RESULTS

### Dosimetric Comparison

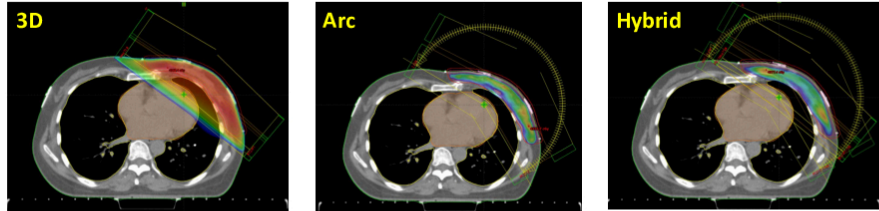


Figure1. The planning images of the left-sided breast cancer with 3DCRT, VMAT, and hybrid plan.

Table1. The differences of the dosimetric indices according to plan techniques.

Index		3D vs Hybrid	3D vs Arc	Arc vs Hybrid
Ipsilateral lung	V5	0.000	0.000	0.000
	V20	0.243	0.000	0.000
	V30	0.502	0.335	0.704
	Dmax	0.062	0.115	0.907
	Dmean	0.001	0.000	0.001
Contralateral lung	V5	0.000	0.000	0.000
	V20	0.343	0.020	0.004
	V30	0.343	0.343	-
	Dmax	0.000	0.000	0.000
	Dmean	0.000	0.000	0.000
Whole lung	V5	0.000	0.000	0.000
	V20	0.293	0.000	0.001
	V30	0.484	0.365	0.640
	Dmax	0.062	0.115	0.907
	Dmean	0.000	0.000	0.000
Heart	Dmax	0.000	0.000	0.018
	Dmean	0.062	0.003	0.050
	Dmax	0.414	0.000	0.000
PTV	Dmean	0.815	0.397	0.493
	V95	0.599	0.599	0.397

Table2. The averages and standard deviations of the dosimetric indices according to plan techniques.

Index		3D		Hybrid		Arc	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Ipsilateral lung	V5	31.96	5.71	64.28	16.80	88.45	12.57
	V20	21.59	4.71	23.92	7.25	39.29	15.65
	V30	18.03	4.29	16.93	5.15	16.18	8.73
	Dmax	4,200.37	113.89	4,131.78	125.55	4,102.19	253.91
	Dmean	972.32	184.38	1,277.85	321.36	1,766.13	431.45
Contralateral lung	V5	0.12	0.50	1.82	3.24	39.82	17.19
	V20	0.00	0.01	-	-	0.05	0.15
	V30	0.00	0.00	-	-	-	-
	Dmax	415.15	825.38	757.06	302.65	1,735.58	507.36
	Dmean	14.49	12.26	176.36	59.09	473.63	118.06
Whole lung	V5	13.84	2.89	28.63	8.69	60.64	12.44
	V20	9.33	2.35	10.33	3.38	16.93	7.11
	V30	7.80	2.16	7.33	2.49	7.01	3.99
	Dmax	4,200.37	113.89	4,131.78	125.55	4,102.19	253.91
	Dmean	428.00	94.98	650.98	172.36	1,029.24	222.84
Heart	Dmax	4,145.18	142.77	3,961.16	164.26	3,723.94	365.65
	Dmean	566.24	221.50	704.77	181.11	970.38	409.19
	Dmax	4,426.17	51.01	4,432.35	37.21	4,592.68	126.17
PTV	Dmean	4,136.36	68.48	4,148.41	40.79	4,170.76	111.35
	V95	87.46	7.74	89.19	3.91	85.89	9.73

### Heart orthogonal length

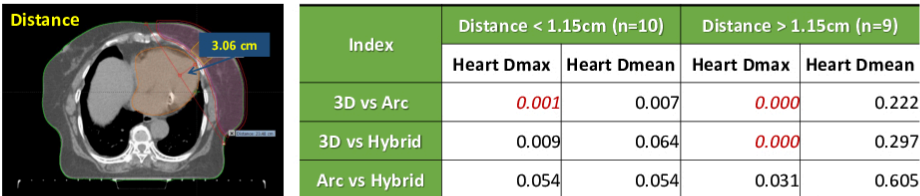


Figure2. The CT image of the patient with the largest heart length, 3.06 cm, and the heart dose according to the orthogonal length.

Table3. The heart dose according to the plan techniques.

[unit: cGy]

Index		Heart Dmax		Heart Dmean	
3D	d<1.15cm	Mean	4,077.31	Mean	462.73
		S.D.	168.76	S.D.	225.57
	d>1.15cm	Mean	4,220.60	Mean	681.24
		S.D.	40.79	S.D.	157.71
Hybrid	d<1.15cm	Mean	3,899.76	Mean	642.27
		S.D.	128.27	S.D.	184.95
	d>1.15cm	Mean	4,029.38	Mean	774.22
		S.D.	179.58	S.D.	158.14
Arc	d<1.15cm	Mean	3,720.78	Mean	942.67
		S.D.	239.56	S.D.	338.48
	d>1.15cm	Mean	3,727.46	Mean	1,001.17
		S.D.	486.05	S.D.	495.79

- A total of 19 left-sided breast hybrid plans were compared with 3DCRT and VMAT plans (Figure 1).
- As a result of comparing dosimetric indices' differences according to plan techniques, there are statistically significant results in three plan techniques, mainly in the low dose and the mean dose (Table 1).
- The mean value of  $V_5$  in the ipsilateral lung were 31.96 and 88.45 cc in 3DCRT and VMAT, respectively (Table 2).
- Even in the contralateral lung, there was almost no dose in 3DCRT, but in VMAT,  $V_5$  was 39.82 cc (Table 2).
- The maximum dose of the heart was 4,145 cGy in 3DCRT and 3,961 cGy in hybrid plan (Table 2).
- The median value of the heart orthogonal length was 1.15 cm, and the heart dose was evaluated by dividing patients into two groups based on this value, the patients were divided into two groups, and the heart dose was evaluated (Table 3).

## CONCLUSIONS

In this study, the dosimetric characteristics of 3DCRT, VMAT, and hybrid plans were compared for the left-sided breast patients. In addition, as a result of evaluating the heart dose according to the anatomical characteristic, when the heart orthogonal length is 1.15 cm or more, the maximum dose of the heart in the 3DCRT plan is 4,220 cGy. Therefore, if the heart orthogonal length is more than 1.15 cm, it is recommended to establish a hybrid plan in terms of heart maximum dose and lung low dose.

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## CONTACT INFORMATION

mpsohyun@gmail.com