

# Using FFF Beams in Electronic Tissue Compensation for Left Sided Whole Breast Irradiation with DIBH

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## INTRODUCTION

Deep-inspiration-breath-hold (DIBH) is a popular technique for left breast radiation therapy as it has been shown to reduce heart dose by up to 80%<sup>1</sup>. Additionally for every 1Gy in mean heart dose, the risk of heart disease and coronary events increases by 4-7%<sup>2</sup>. While the benefits of DIBH are clear, the technique can put a strain on patients with some being unable to perform the breath-hold for the length of treatment.

## AIM

In order to reduce beam-on time, thereby reducing the potential strain on the patient of the DIBH technique, we investigated whether electronic-tissue-compensation (ECOMP) planning technique can be used to create a 6X-FFF plan.

## METHOD

15 left-sided, post-lumpectomy patients were retrospectively re-planned using ECOMP for both 6X and 6X-FFF.

### Plan Creation

- Beam aperture, gantry, and collimator rotation from clinical plan copied for re-planning
- ECOMP plans for both 6X and 6X-FFF created

### Dosimetric Comparison

- Using dosimetric endpoints described in Table 1 the 6X and 6X-FFF plans were compared

### Delivery Feasibility

- The 6X ECOMP plan is copied and energy changed to 6X-FFF to create the 6X-FFF QA plan
- QA plans created and delivered for 6X and 6X-FFF QA plan
- QA analyzed using Portal Dosimetry and gamma analysis with departmental criteria (3%/3mm)
- Beam-on time measured for 6X (600MU/min) and 6X-FFF (1200 MU/min) plans

Statistical Analysis with Mann-Whitney-Wilcoxon signed ranked test with  $p < 0.05$  considered as significant

## RESULTS

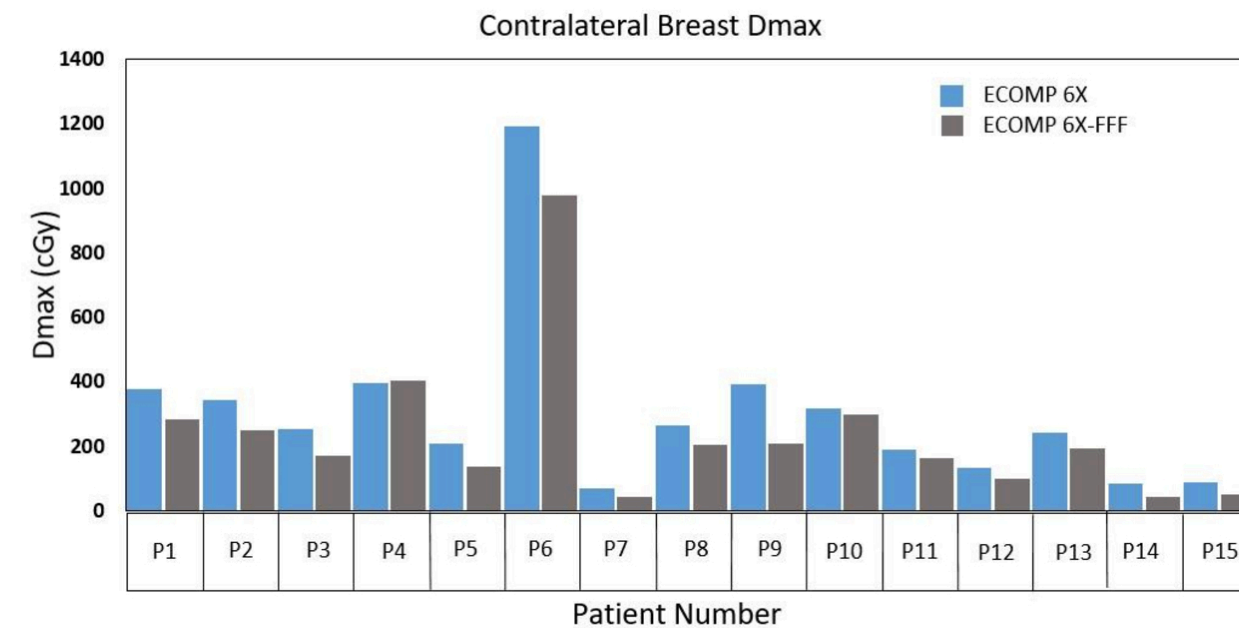


Figure 1: Contralateral breast Dmax comparison between 6X and 6X-FFF plans for all patients.

Dosimetric Endpoints and Comparison				
Structure	Endpoint (units)	6X	6X-FFF	p-value
PTV <sub>e</sub>	V95% (%)	97.3±1.3	97.4±1.2	0.61
	V105% (%)	2.9±3.1	3.4±2.6	0.78
	D <sub>max</sub> (%)	106.2±0.9	106.4±0.7	0.87
Lump PTV <sub>e</sub>	V95% (%)	99.9±0.2	99.9±0.2	n/a
Lump GTV	D <sub>min</sub> (%)	99.3±4.1	99.5±3.1	0.91
Heart	D <sub>mean</sub> (cGy)	76.4±19.8	74.2±17.9	0.12
	D <sub>max</sub> (cGy)	1388.8±875.3	1264.4±776.6	0.5
Ipsilateral Lung	V16Gy (%)	8.8±3.6	8.8±3.3	0.82
Contralateral Breast	D <sub>max</sub> (cGy)	302.5±270.2	233.8±229.4	<b>0.0008</b>
	D <sub>mean</sub> (cGy)	3525.9±35.9	3519.6±29.8	0.31
	D <sub>min</sub> (cGy)	762.3±146.5	790.3±170.6	<b>0.01</b>
Skin	D <sub>max</sub> (cGy)	4469.8±38.4	4441.5±58.3	<b>0.03</b>
	D <sub>min</sub> (cGy)	762.3±146.5	790.3±170.6	<b>0.01</b>

Table 1: Dosimetric comparison between 6X and 6X-FFF ECOMP plans using dosimetric endpoints from departmental criteria. Results are given in mean  $\pm$  1 standard deviation.

Portal Dosimetry  $\gamma$  Passing Rates (3%/3mm)

Patient #	Composite QA 6X 3%/3mm ( $\gamma$ )	Composite QA 6X-FFF 3%/3mm ( $\gamma$ )
1	100	99.8
2	99.8	99.7
3	100	100
4	100	100
5	100	100
6	100	100
7	98.8	98.3
8	100	99.9
9	100	100
10	100	100
11	99.6	99.5
12	100	100
13	100	99.9
14	99	96.1
15	100	100

Table 2: Portal Dosimetry  $\gamma$  passing results with departmental criteria 3%/3mm for both 6X and 6X-FFF QA plans.

Beam-on (Delivery) Times for 6X and 6X-FFF Plans

Patient #	6X Delivery Time (s)	6X-FFF Delivery Time (s)	% Time Decrease
1	46.4	32.5	29.9
2	44.2	34.5	22.0
3	50.1	33.0	34.1
4	56.0	36.4	35.0
5	49.6	39.9	19.6
6	50.7	35.8	29.3
7	49.5	36.9	25.4
8	47.3	34.3	27.5
9	54.2	31.4	42.0
10	51.6	31.4	39.1
11	48.9	30.5	37.6
12	49.7	32.7	34.3
13	58.8	39.2	33.2
14	47.5	30.0	36.8
15	49.1	32.0	34.9

Table 3: Beam-on (Delivery) times for 6X and 6X-FFF plans in seconds and % time decrease ( $p=0.0006$ ).

## CONCLUSIONS

### Dosimetric Comparison

- 6X-FFF ECOMP plans show no statistical difference from 6X ECOMP plans in terms of target coverage. Additionally, the average differences are very minimal and likely clinically insignificant.
- 6X-FFF ECOMP plans show significant increased sparing of the contralateral breast and increased skin homogeneity.

### Delivery Feasibility

- 6X-FFF ECOMP plans showed slightly lower Portal Dosimetry gamma passing rates but all plans still met departmental passing criteria.
- 6X-FFF ECOMP plans had an average beam-on time reduction of 32%.

**6X-FFF plans can be created using ECOMP planning technique that are dosimetrically equivalent, if not better than, 6X plans while reducing beam-on time.**

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