On the Dosimetric Quality of Current External Beam Radiation Technologies for Partial Breast Irradiation

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INTRODUCTION

Accelerated Partial Breast Irradiation (APBI) has shown to yield excellent local control rate and good-to-excellent cosmetic outcomes. The ASTRO evidence-based consensus (PRO; 7, 73-79) does not recommend in favor or against the use of EBRT-based APBI. We evaluated the dosimetric quality of IMRT, VMAT, and IMPT plans for APBI to guide clinical decisions.

METHOD

- Data from twelve patients originally treated with IMRT APBI were used.
- Segmentations of interest : GTV, CTV, PTV, markers, spinal cord, heart, ipsilateral and contralateral lung and breast, and skin (5mm and 10mm from body)
- IMRT plans used 5 beams, normalized to 100% of dose to cover 95% of PTV.
- VMAT plans used 2 half arcs and were normalized the same way as IMRT plans.
- IMPT plans used 2 or 3 beams with SFO optimization and were normalized to 100% of dose to cover 99% of the CTV.
- Prescription used was 3000 cGy given over 5 fractions.
- Photon plans used AAA15603 (Eclipse, Varian) for calculation and proton plans were calculated with RayStation Clinical Monte Carlo v4.4 (RayStation, RaySearch).
- Plan quality parameters for all targets and organs at risk from Livi et al were used.
- Dosimetric analysis was based on conformity, heterogeneity, and uniformity indices to asses PTV coverage, and Student's t-tests were performed.

RESULTS

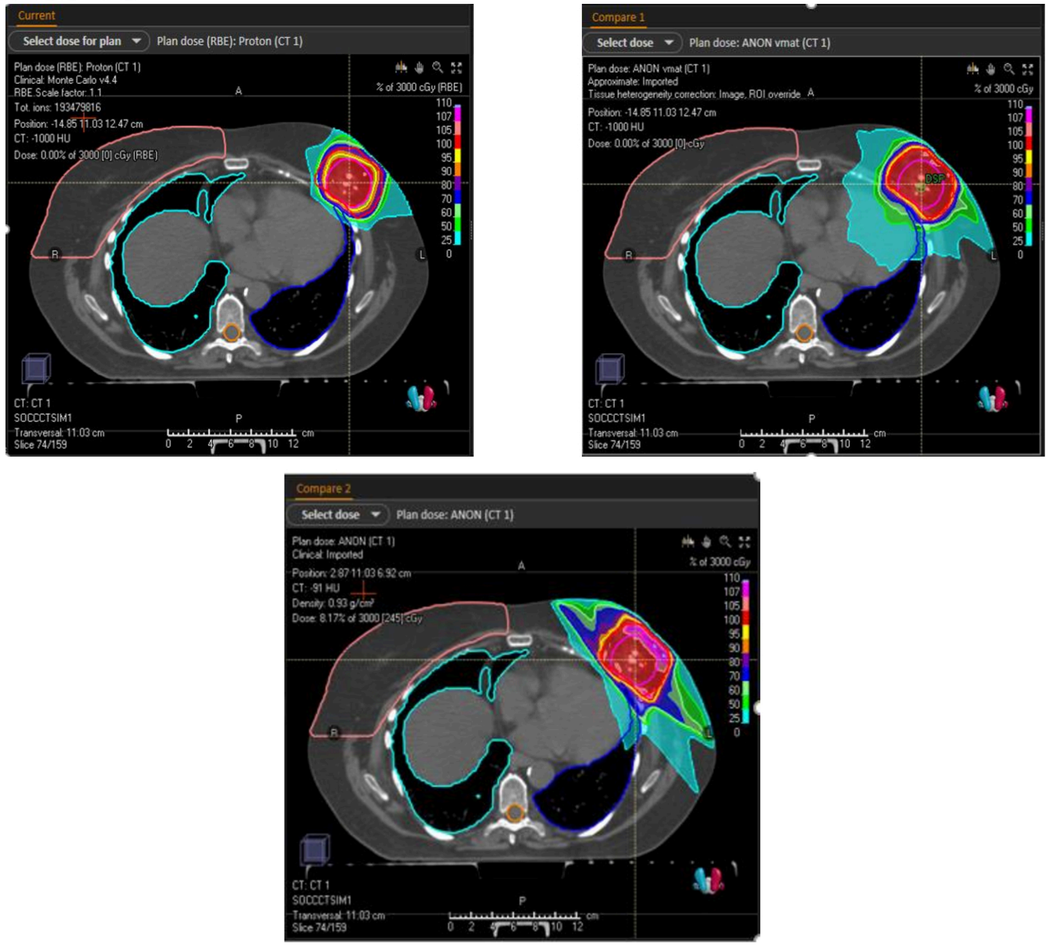

Figure 1: Top left: IMPT dose distribution using two beams and SFO optimization. Top right: VMAT dose distribution using two half arcs. Bottom: IMRT dose distribution using 5 coplanar beams

Volume of Interest	IMRT	VMAT	IMPT	p-value VMAT vs. IMRT	p-value IMRT vs. IMPT	p-value VMAT vs. IMPT
PTV (photon), CTV (proton)	98.72 cm^3	98.72 cm^3	82.18 cm^3			
Max Dose (cGy)	3287.05	3250.53	3215.58	0.1800	0.0104	0.2200
Min Dose (cGy)	2610.10	2653.03	2981.25	0.2060	6.67E-05	1.09E-05
UI (best if =1)	1.06	1.05	1.05	0.0130	0.1519	0.2700
CI (best if =1)	1.22	1.11	1.70	0.0001	6.99E-08	5.18E-08
HI (best if = 0)	0.23	0.20	0.08	0.0119	5.76E-05	2.09E-04
Breast						
Ipsilateral V_{15Gy} (%)	29.50	20.68	17.53	0.0001	0.0058	0.4300
Contralateral Max Dose (cGy)	1.92	3.55	2.41	0.2162	0.00817451	9.43E-06
Skin (5mm depth)						
Min Dose (cGy)	14.24	11.40	2.64	0.4467	5.52E-06	5.04E-05
Max Dose (cGy)	3093.10	3013.33	2568.73	0.0582	0.0028	5.76E-03
Mean Dose (cGy)	581.63	495.56	458.00	0.0026	0.0067	0.1400
Skin (10mm depth)						
Min Dose (cGy)	8.84	10.81	3.08	0.1603	0.0003	1.84E-04
Max Dose (cGy)	3194.52	3175.51	2766.17	0.2427	0.0029	3.19E-03
Mean Dose (cGy)	740.29	643.87	545.75	0.0015	0.0002	7.20E-04
Heart						
V_{3Gy} (%)	7.47	32.96	0.44	0.0148	0.0118	3.25E-03
Lung						
ipsilateral V_{10Gy} (%)	6.73	7.54	2.41	0.0395	0.0103	2.76E-04
contralateral V_{5Gy} (%)	0.04	0.17	0.00	0.7440	0.1956	0.1100
MU Total	1486.92	1321.75	4352.05			

Table 1: Dosimetric quality comparison of APBI IMRT, VMAT, and IMPT plans.

CONCLUSIONS

Comparing the dosimetry of external beam techniques for APBI, this study demonstrated advantages of IMPT. Further study warrants a greater number of patient data and careful post-treatment follow up to create a clinically based consensus.

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