

VMAT vs 7-field-IMRT with MR-linac: Comparison of dosimetric parameters for prostate cancers

D. Lee¹, S. Lee¹, S. Oh¹, R Fuhrer¹, and J. Sohn^{1,2}

¹Radiation Oncology, Allegheny Health Network, Pittsburgh, PA

²Drexel University College of Medicine, Philadelphia, PA



INTRODUCTION

- ✓ The Elekta Unity MR-Linac (Elekta AB, Stockholm, Sweden) has been clinically introduced in 2018.¹⁻⁴
 - Eighteen MR-linac(s) will be available by the end of 2020.
- ✓ **However, treatment planning for MR-linac(s) accounts for machine specific characteristics.**
 - i.e., IMRT and 7FFF only, 1.5 T magnetic field and ring gantry.

AIM

- ✓ Investigate the feasibility of MR-linac planning with 7-field-IMRT.
- ✓ Investigate the comparability of dosimetric parameters between VMAT and 7-field-IMRT plans.
 - 2 Arc(s) VMAT in Linac vs 7-field IMRT in MR-linac.

METHOD

- ✓ Choose 5 VMAT plans received external beam radiotherapy for prostate cancers.
 - Export from Monaco v5.11.02 (Elekta AB, Stockholm, Sweden) as a DICOM format.
 - Import to Monaco v5.40.01 to develop 7-field-IMRT plans.
- ✓ Develop corresponding 7-field IMRT plans.
 - Use the same structures and prescriptions (46 Gy with 23 fx(s) for 4 plans and 70 Gy with 28 fx(s) for a plan).
 - Use a 7FFF energy, gantry angles at every 51°, collimator 0°, an MR coil, MR couch components, beam isocentre at 143.5 mm and dose rates up to 450 MU/min.
- ✓ Evaluate the plan quality of 7-field-IMRT plans.
 - Compare the dosimetric parameters between VMAT and 7-field IMRT plans.
 - PTV, Rectum, Bladder and left/right Femoral Heads in volume, prescription dose constraints and mean dose.

RESULTS

- ✓ An absolute difference of mean dose, across five plans, was negligible ($\leq 2\%$) to PTV V100RX > 98%, but it varied in Rectum V38Gy ($\leq 66\%$), Bladder 35Gy ($\leq 49\%$) and left/right Femoral Heads 28Gy ($\leq 22\%$).
- ✓ The maximum difference of reference volume also varied in PTV (0%), Rectum ($\leq 22\%$), Bladder ($\leq 26\%$) and left/right Femoral Heads ($\leq 0.5\%$).

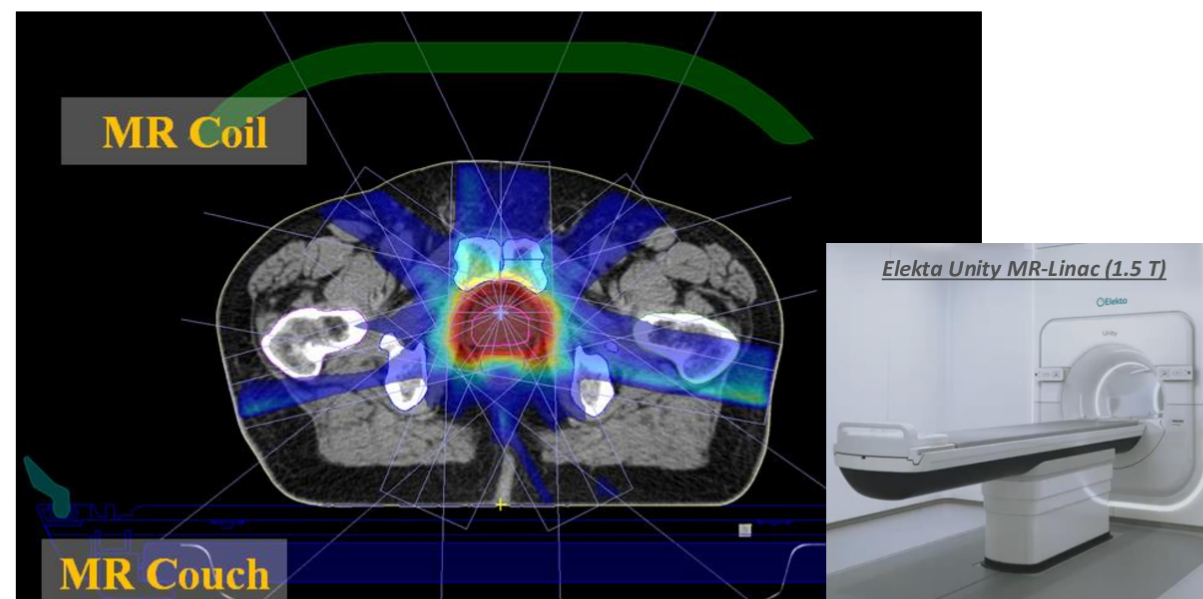


Figure 1. An example of 7-field-IMRT plan (Patient #5). An MR coil and MR couch were used. A 7FFF beam was also used with plan parameters (i.e., Gantry angles at every 51°, collimator 0°, an MR coil, MR couch components, beam isocentre at 143.5 mm and dose rates up to 450 MU/min).

Structure	Dosimetric Parameters	Patient #1			Patient #2			Patient #3			Patient #4			Patient #5		
		VMAT	7-IMRT	Diff. (%)	VMAT	7-IMRT	Diff. (%)	VMAT	7-IMRT	Diff. (%)	VMAT	7-IMRT	Diff. (%)	VMAT	7-IMRT	Diff. (%)
PTV	Vol. (cm ³)	62.0	62.1	0	110.2	110.7	0	132.2	132.3	0	107.4	107.2	0	87.4	87.4	0
	V100RX (cm ³)	60.9	60.9	0	108.0	108.4	0	129.4	129.7	0	105.3	105.1	0	85.8	85.7	0
	V100RX (%)	98.3	98.0	0	98.0	98.0	0	97.9	98.0	0	98.0	98.0	0	98.1	98.0	0
	Mean Dose (cGy)	7396.9	7273.0	-2	4845.9	4858.5	0	7305.6	7225.0	-1	4769.3	4793.8	0	4859.6	4853.0	0
Rectum	Vol. (cm ³)	99.5	99.3	0	68.6	68.6	0	119.4	119.2	0	83.6	83.6	0	59.3	59.2	0
	V38Gy (cm ³)	16.9	22.6	34	3.4	4.2	25	10.7	34.0	219	6.9	5.1	-25	6.0	6.2	5
	V38Gy (%)	17.0	22.7	34	4.9	6.2	25	9.0	28.6	219	8.2	6.1	-25	10.0	10.6	5
	Mean Dose (cGy)	2544.8	2933.8	15	1732.7	1649.7	-5	2274.1	3012.5	32	1118.2	1540.4	38	1206.9	1997.7	66
Bladder	Vol. (cm ³)	292.6	292.4	0	160.3	160.2	0	173.5	173.4	0	234.3	234.1	0	206.0	206.0	0
	V35(cm ³)	29.3	36.9	26	21.9	33.5	53	6.9	40.3	484	17.1	26.7	57	25.9	40.7	57
	V35Gy (%)	10.0	12.6	26	13.6	20.9	53	4.0	23.3	483	7.3	11.4	57	12.6	19.8	57
	Mean Dose (cGy)	1240.6	1319.1	6	1650.0	2091.9	27	1899.6	2315.0	22	856.8	1276.9	49	1406.1	1866.2	33
Femoral Head_L	Vol. (cm ³)	188.8	188.6	0	202.9	202.6	0	233.7	233.5	0	185.0	184.8	0	218.2	217.2	0
	V28Gy (cm ³)	0.0	0.0	0	0.0	0.1	0	0.0	0.0	0	0.0	1.0	0	0.0	0.0	0
	V28Gy (%)	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.5	0	0.0	0.0	0
	Mean Dose (cGy)	1206.9	1373.0	14	1165.2	1268.5	9	1628.9	1562.9	-4	949.0	1130.5	19	872.9	1061.5	22
Femoral Head_R	Vol. (cm ³)	181.5	181.3	0	212.6	212.6	0	233.6	233.2	0	196.7	197.1	0	218.6	218.2	0
	V28Gy (cm ³)	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
	V28Gy (%)	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
	Mean Dose (cGy)	1250.0	1612.2	29	1267.2	1316.9	4	1703.5	1431.7	-16	956.3	900.4	-6	860.0	729.8	-15

Table 1. Comparison of dosimetric parameters between VMAT and 7-field-IMRT plans. A smaller number of Diff. (%) indicates higher similarity. Larger differences of mean dose, compared with VMAT plans, are noticed in rectum, bladder and left/right femoral heads but they are much smaller than the constraints to the OARs.

CONCLUSIONS

- ✓ This study developed 7-field-IMRT plans with a minimal difference of mean dose on PTV, compared with clinical VMAT plans.
- ✓ Larger differences of mean dose were found in rectum, bladder and left/right femoral heads but they are still lower than dose tolerance (dose objectives).
- ✓ It will be potential for 7-field-IMRT based SBRT prostate patients in the Elekta Unity MR-Linac.

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CONTACT INFORMATION

Danny Lee, PhD, E: danny.lee@ahn.org.
Allegheny Health Network (<https://www.ahn.org>).