Abstract Overview

Clinical Validation of AI Prostate SBRT Plans: Comparison to Manual Plans and Generalization From 36.25 Gy to 40 Gy

Authors: Nayoon J Lee, Anran Zhao, , Ledi Wang , Steven Philbrook , William R Green , Madalina-Liana Costea, Baris Ungun, Remi Vauclin, Elie Mengin, Nikos Paragyos, Rafe A McBeth

Purpose

- To evaluate generalization from the vendor-trained 36.25 Gy/5 regimen to the local 40 Gy/5 standard at UPENN hospital.

Mat&Methods

- Nr of patients: 23 treated on Halcyon Machine.
- Model training: prescription 36.25 Gy/5fx without urethra sparing.
- Quantitative criteira : institutional SBRT constraints including urethra sparing, bladder wall, rectal wall , femoral heads and penile bulb.

Results

- The AI plans were generated in less than 10 min and consistently used 2 arcs and less MUs, while the manual plans balistics varied between 2 and 3 VMAT arcs.
- The AI plans generalized to 40Gy regimen only through normalization, preserving target coverage and favorable doses to most of OARs.
- Constraints deviations were in structures not included in the model training: Urethra D0.035 cc limit at 40 Gy by a mean of ~101 cGy.

Conclusion

- SmartPlan produced clinically competitive plans with successful generalization across institutional practice variations, demonstrating improved planning efficiency. Two targeted areas for improvement have been identified: The integration of MR-based urethral contours into the planning workflow, and vendor model updates that explicitly optimize urethral constraints.

- Improves planning efficiency and consistency.
  Generating high-quality SBRT plans in <10 minutes with standardized delivery and fewer monitor units.
- Enables use across institutional practices.
  Demonstrating successful generalization from 36.25 Gy/5 to 40 Gy/5 while preserving target coverage.
- Supports clinical implementation with minimal customization.
  Achieving high constraint adherence (~93.5%) and identifying clear, addressable areas for improvement.

Plan Performance Summary Statistics

			Mean_Dose		Median_Dose		Min_Dose		Max_Dose		Average Constraint Delta		Average Difference	Pass_Rate	
Metric	Constraint_Value	Constraint_Type	AI (TheraAuto)	Human (Initial)	AI (TheraAuto)	Human (Initial)	AI (TheraAuto)	Human (Initial)	AI (TheraAuto)	Human (Initial)	AI (TheraAuto)	Human (Initial)	(AI - Human)	AI (TheraAuto)	Human (Initial)
PTV_4000_CI_Paddick_4000cGy	1	Min Dose (>=)	0.9	0.9	0.9	0.9	0.8	0.8	0.9	0.9	-0.1	-0.1	0.0	100.0%	100.0%
PTV_4000_D95%[cGy]	4000	Min Dose (>=)	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	0.0	0.0	0.0	100.0%	100.0%
PTV_4000_D99%[cGy]	3600	Min Dose (>=)	3885.7	3916.7	3889.7	3919.8	3750.4	3836.4	3932.4	3954.7	-285.7	-316.7	-31.0	100.0%	100.0%
BladderWall_D0.035cc[cGy]	4200	Max Dose (<=)	4089.8	4146.3	4090.0	4157.2	4046.8	4042.2	4122.9	4194.2	+110.2	+53.7	-56.5	100.0%	100.0%
BladderWall_D50cc[cGy]	1825	Max Dose (<=)	267.1	202.3	202.2	132.4	91.1	43.7	762.5	835.6	+1557.9	+1622.7	+64.8	100.0%	100.0%
External_Pat_Max[cGy]	4280	Max Dose (<=)	4240.0	4259.3	4240.0	4259.3	4240.0	4259.3	4240.0	4259.3	+40.0	+20.7	-19.3	100.0%	100.0%
FemoralHeads_D10cc[cGy]	3000	Max Dose (<=)	1273.0	1451.6	1231.4	1453.6	1095.3	1074.2	1578.8	2067.0	+1727.0	+1548.4	-178.6	100.0%	100.0%
PenileBulb_D0.035cc[cGy]	3150	Max Dose (<=)	1319.1	1360.9	732.4	873.1	231.4	174.5	3685.8	3128.2	+1830.9	+1789.1	-41.8	87.0%	100.0%
PenileBulb_D3cc[cGy]	2500	Max Dose (<=)	275.0	236.9	259.3	215.2	128.0	76.3	448.1	509.2	+2225.0	+2263.1	+38.1	100.0%	100.0%
PenileBulb_Mean[cGy]	1000	Max Dose (<=)	400.7	376.1	345.5	323.4	154.7	99.1	889.2	898.5	+599.3	+623.9	+24.6	100.0%	100.0%
RectalWall_D0.035cc[cGy]	4200	Max Dose (<=)	3934.7	3983.9	3971.4	4058.5	3709.0	3287.4	4079.0	4161.5	+265.3	+216.1	-49.2	100.0%	100.0%
RectalWall_D33%[cGy]	3900	Max Dose (<=)	1585.9	1437.1	1589.8	1340.3	1270.1	911.5	1996.5	2135.4	+2314.1	+2462.9	+148.8	100.0%	100.0%
RectalWall_D50%[cGy]	2400	Max Dose (<=)	1146.5	1015.7	1148.9	945.5	857.3	482.8	1424.5	1572.5	+1253.5	+1384.3	+130.7	100.0%	100.0%
RectumSuperior_D0.035cc[cGy]	3000	Max Dose (<=)	412.8	302.7	388.7	285.2	151.6	101.0	1480.0	771.5	+2587.2	+2697.3	+110.1	100.0%	100.0%
RectumSuperior_D10cc[cGy]	2500	Max Dose (<=)	152.9	94.6	160.2	98.1	78.6	41.4	234.6	164.5	+2347.1	+2405.4	+58.3	100.0%	100.0%
Skin_D0.035cc[cGy]	2000	Max Dose (<=)	1139.2	950.2	1117.1	951.5	973.8	671.5	1325.2	1090.6	+860.8	+1049.8	+188.9	100.0%	100.0%
SmallBowel_D0.035cc[cGy]	2900	Max Dose (<=)	123.1	76.2	94.5	52.2	34.9	15.2	447.1	300.3	+2776.9	+2823.8	+46.9	100.0%	100.0%
SmallBowel_D10cc[cGy]	1950	Max Dose (<=)	88.0	50.5	73.3	39.2	29.3	11.2	240.4	159.2	+1862.0	+1899.5	+37.5	100.0%	100.0%
Urethra+3mm_D0.035cc[cGy]	4200	Max Dose (<=)	4180.9	4132.3	4161.7	4135.1	4099.6	4066.4	4353.5	4189.0	+19.1	+67.7	+48.6	82.6%	100.0%
Urethra_D0.035cc[cGy]	4050	Max Dose (<=)	4150.8	4010.2	4132.9	4014.6	4092.3	3959.4	4326.6	4048.8	-100.8	+39.8	+140.6	0.0%	100.0%

Internal