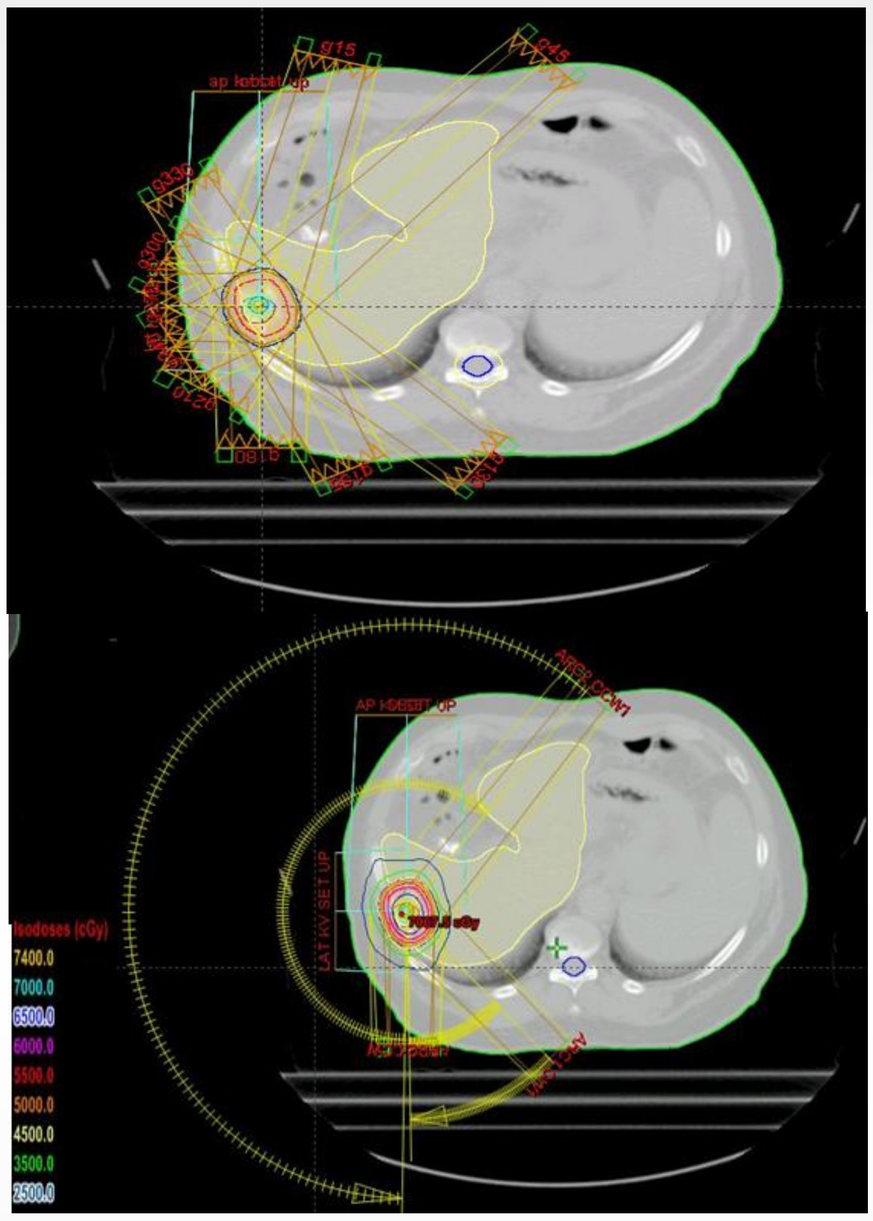
Comparison between IMAT and IMRT planning for stereotactic body radiation therapy (SBRT) of hepatocellular carcinoma (HCC)

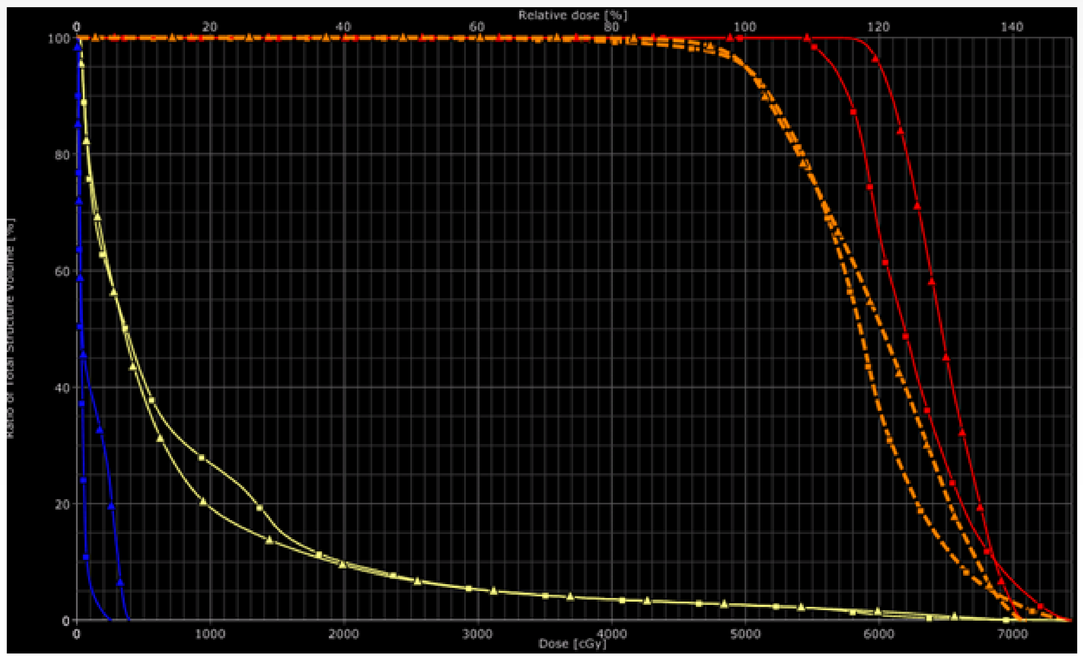
Anna O Simeonova M.D.,* Steve Rhodes B.S., † Florian Stieler M.Sc.,* James A Tanyi Ph.D., † Martin Fuss M.D., Ph.D. †

*Department of Radiation Oncology, University Medical Center Mannheim, University of Heidelberg, Germany
†Department of Radiation Medicine, Oregon Health & Science University, Portland, Oregon, USA
E- Mail: anna.simeonova@umm.de

Background: To assess the potential of intensity-modulated arc therapy (IMAT) for SBRT planning and delivery for patients with hepatocellular carcinoma (HCC). We compared IMAT plans with our standard static gantry intensity-modulated radiation therapy (IMRT) planning technique.



Materials and methods: This virtual planning study was performed on 26 patients previously treated by SBRT for HCC. Plans were generated in Eclipse® (Varian Medical Systems). Based on 4DCT scans, an internal target volume (ITV) was delineated and expanded by 5 mm into a planning target volume (PTV). Two treatment planning techniques were compared – static field IMRT (9 to 11 fields, the clinically used plan) and IMAT (RapidArc®, Varian). The prescribed dose (PD) was 50 Gy in 5 fractions to 95% of the PTV, and all plans were computed heterogeneously with a planned dose maximum of ~150% of PD. DVH parameters for the PTV (D_{mean}, D_{max}, and D_{min}) and for the normal liver (liver minus ITV) (D_{mean}, $D_{30\%}$ and $D_{50\%}$) were obtained. We also recorded monitor unit (MU) usage and estimated radiation delivery times. Two-way comparisons were performed using the Wilcoxon signed ranks test (significance level $p<0.05$).



PTV			
	IMAT	**IMRT**	**p-value**
D_{mean}			
Mean	61 ± 1.6	60.1 ± 1.9	**0.02**
Range	59.1-66	55.6-64.7	
$D_{99\%}$			
Mean	46 ± 1.1	45 ± 1.5	**0.02**
Range	43.1-48.4	43.1-48.4	
D_{min}			
Mean	37 ± 2.1	35 ± 4.3	**0.02**
Range	32-40.5	25.6-42.4	

Normal liver			
	IMAT	**IMRT**	**p-value**
D_{mean}			
Mean	6.4 ± 2.1	6.7 ± 2.2	**0.013**
Range	37957,0	2.1-13.2	
$D_{30\%}$			
Mean	6 ± 3.4	6.2 ± 4.2	**0.6**
Range	0.2-14.2	0-19.6	
$D_{50\%}$			
Mean	2 ± 1.5	2.1 ± 2	**0.73**
Range	0.1-5.2	0-9.5	

Results: D_{mean} values to the PTV were significantly higher in IMAT plans (61± 1.6 Gy vs. 60.1±1.9 Gy; p=0.02). IMAT plans showed also significantly higher D_{min} values, compared to IMRT (p=0.02). The mean dose to the normal liver was statistically significantly lower in the IMAT plans (6.7±2.2 Gy vs. 6.4±2.1 Gy; p=0.013). There was no statistically significant difference in D30% and D50% of normal liver. MU usage in IMAT plans was significantly lower, compared to IMRT plans (2135±243 MU vs. 3277±957 MU; p<0.001). Radiation beam delivery times were significantly shorted for IMAT plans.

Conclusions: IMAT resulted in higher mean PTV doses at the standardized coverage, which may afford higher probability of tumor kill and afforded statistically significant decrease in the D_{mean} to the normal liver. This may become clincially relevant in typical HCC patients with underlying chronically compromized liver function. The estimated decrease in radiation delivery times using IMAT techniques will reduce potential intra-fraction patient movement.