

Purpose: To optimize hippocampus sparing in whole brain radiotherapy planning by utilizing available features in commercial treatment planning systems.

Method: Seven patients previously treated with 30Gy in 10 fractions of whole-brain radiotherapy with hippocampal-avoidance under NRG-CC001 clinical trial protocol were reviewed. Previous plans were designed with two to three VMAT arcs at couch 0°. New plans were generated in Eclipse v13.7 using two full arcs (181°-179°) at couch 0°, collimator (30° and 330°), and two half arcs (0°-179°) at couch 90°, collimator (0° and 90°). A 40° avoidance sector (340°-20°) for each full arc was assigned, while a 30° avoidance sector (80°-110°) was assigned for each half arc. Jaw tracking was enabled in each plan. Upper, lower, and mean optimization objectives for PTV coverage and OARs (eyes, lens, optic nerves and chiasm) sparing were set to meet NRG-CC001 dose constraints and compliance criteria. In addition, generalized uniform equivalent dose gEUD feature was utilized; target and upper gEUD objectives for PTV and OARs were assigned, the corresponding alpha value of each structure's gEUD was entered based on AAPM TG-166. Paired t-tests were used to identify significant dosimetric differences between previously treated plans and new generated plans.

Organ	α value
PTV	-10
GTV	-10
Cord	20
Parotid	1
Rectum	8
Bladder	8
Mandible	10
Femoral head	12
Brainstem	16
Chiasm	16
Eye	16
Optic nerve	16



	Chiasm	0.3				
	Upper	<input type="text" value="0.0"/>	<input type="text" value="3000"/>	<input type="text" value="3310"/>	<input type="text" value="200"/>	
	Mean		<input type="text" value="2900"/>	<input type="text" value="3191"/>	<input type="text" value="200"/>	
	Upper gEUD		<input type="text" value="3000"/>	<input type="text" value="3192"/>	<input type="text" value="190"/>	<input type="text" value="5.0"/>
	Hippocampi	4.4				
	Upper	<input type="text" value="100.0"/>	<input type="text" value="780"/>	<input type="text" value="948"/>	<input type="text" value="250"/>	
	Upper	<input type="text" value="0.0"/>	<input type="text" value="1450"/>	<input type="text" value="1522"/>	<input type="text" value="220"/>	
	Upper gEUD		<input type="text" value="1100"/>	<input type="text" value="1201"/>	<input type="text" value="200"/>	<input type="text" value="10.0"/>
	Hippocampi_06	28.9				
	Upper	<input type="text" value="0.0"/>	<input type="text" value="1450"/>	<input type="text" value="2359"/>	<input type="text" value="220"/>	
	Upper	<input type="text" value="100.0"/>	<input type="text" value="800"/>	<input type="text" value="948"/>	<input type="text" value="230"/>	
	Upper gEUD		<input type="text" value="1500"/>	<input type="text" value="1813"/>	<input type="text" value="190"/>	<input type="text" value="10.0"/>

Fig 1&2: gEUDs alpha values and optimization objectives.

Plan Information						
General: Stewart Lucile D (0637607)/C2 Practice/Brain_NROC002						
Dose Prescription: 3000 cGy						
Treatment Unit: TrueBeam18X600						
MLC: Millennium_120/Varian Medical Systems/Millennium 120						
Fields: Scale: Varian IEC						
ID	Gantry Rotation	Couch Angle	Collimator Angle	Energy	MU	
Arc 2	181.0CW179.0	0.0	30.0	6X	201	
Arc 1	179.0CCW181.0	0.0	330.0	6X	296	
Arc 3	0.0CW179.0	90.0	0.0	6X	136	
Arc 4	179.0CCW0.0	90.0	90.0	6X	140	
Jaw Tracking						
ID	Couch Angle	Collimator Angle	Gantry Rotation	Avoidance Sector 1	Avoidance Sector 2	
Arc 2	0.0	30.0	181.0CW179.0	340.0	20.0	
Arc 1	0.0	330.0	179.0CCW181.0	20.0	340.0	
Arc 3	90.0	0.0	0.0CW179.0	80.0	110.0	
Arc 4	90.0	90.0	179.0CCW0.0	110.0	80.0	

Fig 3: Arcs configuration, avoidance sectors and jaw tracking.

Results: All seven new treatment plans meet NRG-CC001 doses requirements. Maximum dose to hippocampus was 10.6% lower on average ($p < 0.05$), plans dosimetric quality parameters were not compromised; conformity index CI ($p > 0.05$); homogeneity index HI ($p > 0.05$); hotspots ($p > 0.05$), doses to OARs complied with dose constraints, and number of total monitor units per plan was not significantly different ($p > 0.05$) despite using more arcs compared to previously treated plans.

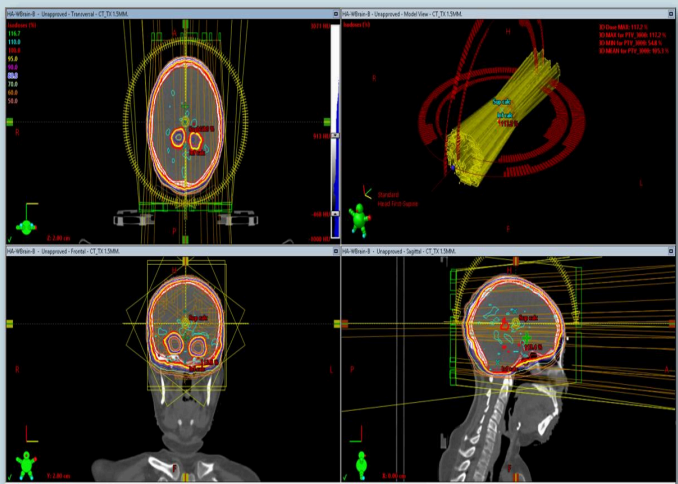


Fig 4: Isodose lines of hippocampal sparing in whole brain RT

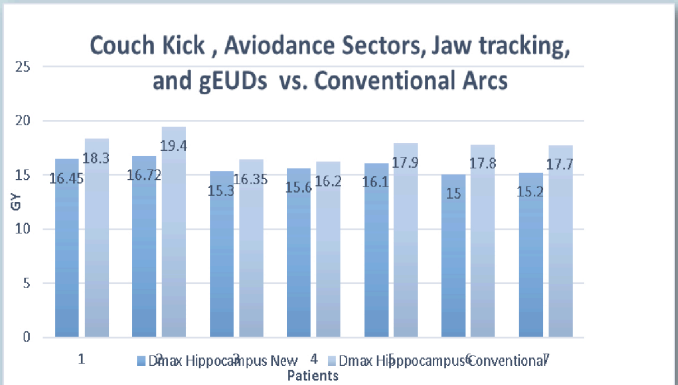


Fig 5 :Couch Kick , Avoidance Sectors, Jaw tracking, and gEUDs vs. Conventional Arcs

Conclusion: The new treatment planning approach achieves a superior hippocampus avoidance up to 15% without compromising PTV coverage, OARs sparing, or plan quality. The reduction of hippocampus Dmax increases tolerance for potential dose escalation intended to individual metastases to further improve outcomes.