

# Dosimetric Comparison of IMRT and Rapid ARC for High Grade Gliomas

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## ABSTRACT

**Background:** High grade gliomas are common intracranial tumors and adjuvant radiotherapy after maximal safe surgical resection is the cornerstone of the management. **Aim:** The aim of the present study was to compare the dose distribution characteristics in patients with high grade gliomas planned with Intensity-modulated radiotherapy (IMRT) and Rapid Arc (RA). **Methods:** Two plan sets by IMRT and RA were generated for each patient on planning Computed Tomography (CT) data sets and were then compared. **Results:** Total dose prescribed was 60 Gy given in biphasic manner as per Radiation Therapy Oncology Group (RTOG) guidelines. Planning Target Volume (PTV) coverage (mean values) for IMRT was found 98% and 96% for RA. Conformity Index (CI) was 1.3 for RA, 1.2 for IMRT. Homogeneity Index (HI) was found to be 1.03 for IMRT, 1.04 for RA. Dose maximum (Dmax) for the PTV was equal for IMRT and RA (106%). **Conclusions:** The dose to Organ at Risks (OARs) was within the acceptable limits and comparable in both the techniques, however RA augments shorter treatment time.

**Keywords:** Glioma, IMRT, Conformal.

## INTRODUCTION

High grade gliomas are common intracranial tumors in adults and surgery followed by post-operative radiotherapy (RT) has been found to significantly prolong the survival.<sup>[1]</sup> With advancements in technology, precise RT techniques have been increasingly used in clinical practice. It aims at improving the dose distribution to the tumor while reducing the dose to normal tissues. Intensity-modulated radiotherapy (IMRT) and RapidArc (RA) are two recent techniques through which precise RT can be delivered. The aim of the present study was to compare these two recent advanced RT techniques in terms of dose distribution characteristics in patients of high grade gliomas.

## MATERIALS & METHODS

Planning CT data sets of 15 patients with high grade glioma were retrieved. Before RT planning, patients were simulated in supine position with thermoplastic cast (for immobilization). CT scans were done with

3 mm slice thickness. Two plan sets by IMRT and RA were generated for each patient and were then compared. Total dose prescribed was 60 Gy given in biphasic manner as per RTOG guidelines. The target volumes were defined by post-operative Magnetic Resonance Imaging (MRI). Clinical target volume (CTV) 1=T1 enhancement and T2 FLAIR + 1.5cm. CTV 2= T1 enhancement +1.5cm. CTV was modified as per anatomical boundaries .PTV was created by giving an isotropic expansion of 0.5cm to CTV. PTV 1 was given 46Gy and PTV 2 received boost of 14 Gy. All techniques were generated using the ECLIPSE Planning System. For each technique used dose volume histograms (DVH) for the target and OARs were obtained. Plan evaluation was done by analyzing slice by slice coverage, HI, CI. The number of monitor units (MU) and number of beams used were also analyzed. CI was defined as the ratio of volume of 95% isodose and PTV volume. HI was calculated as the ratio of dose received by 5% and dose received by 95%.

## RESULTS

PTV coverage was higher for IMRT (98%) than for RA (96%). CI was 1.3 for RA, 1.2 for IMRT .HI was found to be 1.03 for IMRT and 1.04 for RA. Dose maximum (Dmax) for the PTV was equal for IMRT and RA (106%). The dose to OARs was within the

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acceptable limits in both the techniques. IMRT and RA were advantageous when PTV was near to OARs [Table 1]. The number of MU was 1.3 times lower for RA as compared to IMRT.

**Table 1: Comparison of dosimetric parameters (mean)**

	RA	IMRT
HI(mean)	1.03	1.04
CI(mean)	1.32	1.14
Dmax	106	106
Brainstem(Dmax)	48.2	47.4
Opt nerve(Dmax)	37.6	35.2
Opt chiasm(Dmax)	38.8	35.4

## DISCUSSION

High grade gliomas are rapidly growing intracranial tumors with surgical resection followed by adjuvant radiotherapy being current standard of care; with a proven role of temozolamide in grade IV tumors. Complete resection is usually not possible because of infiltrative growth pattern, no nearby anatomical barrier with surrounding brain parenchyma and in certain cases being located adjacent to critical structures.<sup>[1-3]</sup> Post-operative radiotherapy has been found to significantly prolong the survival.<sup>[1,4]</sup> Partial brain irradiation does not jeopardize the outcome as most of the recurrences have been found to be within 2cm of the enhancing edge of the tumor.<sup>[5]</sup> The main challenge in this scenario is the optimal target coverage while minimizing the doses to the adjacent critical structures. Focusing on to maximal sparing of normal structures may translate into sub-optimal target coverage as evident in the quality assurance article regarding the randomized phase III EORTC/NCIC trial.<sup>[6]</sup> More than 50% of patients in this study had tumors in close proximity of critical structures; for 19% patients field size was reduced to decrease the dose to these structures and 39% of the participating centers registered PTV under-dosage. Various studies suggest that IMRT leads to a more conformal and homogenous dose distribution while reducing doses to OAR.<sup>[7-15]</sup> For the reasons mentioned, the use of precision RT has increasingly been employed in recent years.<sup>[16-18]</sup>

Wagner et al and Thilmann et al, in their dosimetric study, found that IMRT achieved better target coverage as compared to 3DCRT, with V95% improvement of 13.5 and 13.1%, respectively.<sup>[7,9]</sup> It was more pronounced when PTV was in close proximity to OAR. Chen et al reported that IMRT allowed better sparing of OAR than 3DCRT, but there was no significant difference in toxicities between the IMRT and 3DCRT.<sup>[19]</sup> Another dosimetric study reported that IMRT always give better coverage than 3DCRT in all the clinico-dosimetric scenarios; the more the number of PTV-OARs overlaps, the better the target coverage by IMRT with respect to 3DCRT.<sup>[20]</sup>

Literature review suggests that most of the dosimetric studies have compared 3DCRT and

IMRT and these studies have reported that IMRT leads to a more conformal and homogenous dose distribution while reducing doses to OAR but none of the studies have compared IMRT and Volumetric arc therapy. We found that overall IMRT was found to be the superior technique in terms of achieving various dose volume parameters. IMRT offered best CI and HI with minimum doses to OARs. RA also achieved various dosimetric parameters comparable to IMRT with its distinctive advantages like lesser MU hence shorter treatment time, thus possible lesser intrafraction errors.

## CONCLUSION

IMRT and RA improves plan quality indices. RA achieves almost similar conformity as IMRT but with lesser MUs therefore shorter treatment time.

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