

Purpose: to validate the clinical effectiveness of Control Point Analysis (CPA) software and establish a comprehensive quality assurance (QA) program for Volumetric Modulated Arc Therapy (VMAT) treatment.

Methods: The comparison and gamma analysis of ArcCHECK™ measurement and treatment planning system (TPS) is considered one of the common methods for VMAT QA procedure. However, questions like 'how QA discrepancies affect patient treatment' and 'what are the sources of discrepancies' cannot be answered. In this study, 3DVH™ and recently developed CPA software were tested for eight cases, including prostate, brain, head&neck, and TG119 phantom cases. All VMAT plans used two arcs, with various settings of couch rotation, collimator rotation, and splitting fields. Each single arc was equally divided into 24 sub-arcs and doses of sub-arcs were exported for CPA analysis. Gamma analyses (3mm/3%) were compared using the ArcCHECK dose, single arc doses, sub-arc doses, and 3DVH patient's dose estimated by Planned Dose Perturbation™ (PDP) algorithm.

Results: ArcCHECK composite dose analyses were consistent with CPA sub-arc analysis for most cases. 3DVH generally showed higher passing rate in dose voxel-by-voxel comparison. Cases with failed QA were further analyzed by CPA for each sub-arc to reveal the sources of dose discrepancies, whether they are mechanical errors (i.e. leaf motion failure) or dosimetric modeling errors (i.e. elongated beam spot size or incorrect dynamic leaf gap). CPA analysis showed values for cases with passed QA to detect small discrepancies caused by failed MLC which was otherwise smeared out in the composite dose comparison.

Conclusions: CPA analysis expands QA process to a greater level of details without additional work by users. With the additions of CPA analysis and 3DVH™, one can establish a comprehensive VMAT QA program with detailed mapping of composite dose passing rate, the estimated effect of discrepancies on patients, and possible sources of discrepancies.

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