

ABSTRACT

Patient-Specific Quality Assurance (PSQA) is a critical step in radiotherapy to ensure the accuracy of dose distribution in treatment planning, particularly for advanced techniques such as Volumetric Modulated Arc Therapy (VMAT). One of the most commonly used evaluation methods in PSQA is gamma analysis, which incorporates dose difference (DD) and distance-to-agreement (DTA) criteria. This study aims to evaluate the impact of variations in gamma analysis criteria and normalization methods on the Gamma Passing Rate (GPR) in PSQA for nasopharyngeal VMAT treatment plans. The study was conducted using 20 nasopharyngeal VMAT treatment plans. Gamma analysis was performed using various criteria, including 3%/3 mm, 3%/2 mm, 2%/3 mm, and 2%/2 mm, with both global and local normalization applied. The primary parameter analyzed was the GPR for each variation. The results showed that stricter gamma criteria led to a decrease in GPR values. A reduction in the DTA criterion from 3 mm to 2 mm resulted in a more significant decrease in GPR compared to reducing the DD criterion from 3% to 2%. The strictest criterion, 2%/2 mm, yielded the lowest mean GPR of $70.7 \pm 3.3\%$. Furthermore, the application of local normalization consistently produced lower GPR values compared to global normalization across all criteria. This study demonstrates that the DTA parameter has a more dominant influence than DD in reducing GPR, while local normalization increases sensitivity to dose deviations but results in lower GPR values. Therefore, the selection of gamma analysis parameters should consider a balance between error detection sensitivity and clinical relevance in VMAT PSQA evaluation.

Keywords: Gamma analysis, gamma passing rate, patient-specific quality assurance, VMAT.