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A Comparative Analysis of the use of Electronic Portal Image Device and Diode Array-Based Patient Specific Quality Assurance for Multi-Met Intracranial Stereotactic Radiotherapy Patients

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Abstract

Objectives:

To compare the performance of two commonly used Quality Assurance (QA) methods, Electronic Portal Image Devices (EPIDs) and diode array-based QA, for Multi-Met Intracranial Stereotactic Radiotherapy (SRS) treatments. Specifically, the study aimed to identify factors that may impact the choice of QA method, evaluate the clinical significance of differences in gamma pass rates, and determine if any factors such as the number of lesions treated, the range of tumor volumes, and the mean distance of tumor distance from isocenter on have an effect on QA performance.

Methods:

Data from 25 previously treated patients who underwent multi-met SRS treatments were retrospectively analyzed. Portal Dosimetry measurements were obtained using an EPID, while diode array-based QA was performed using a commercially available system. EPID images were acquired at a source-to-imager distance of 100 cm. A composite image was generated by summing the individual field images. The diode array was placed in a phantom and the beams were delivered to generate true composite image. Gamma pass rates were calculated for both EPID and diode array measurements using 3%/2 mm, 2%/2 mm, and 2%/1 mm criteria. Correlation analysis was performed to identify factors influencing gamma pass rates. Pearson correlation coefficients were calculated between gamma pass rates and treatment parameters for both EPID and diode array measurements.

Results:

Correlation analysis revealed that the number of lesions treated and total tumor volume had the largest correlation coefficients found in this study with gamma pass rates for EPID measurements, suggesting a stronger relationship between these factors and gamma pass rates when using EPID-based QA. For diode array measurements, no significant correlation was found between the number of lesions and gamma pass rates, although total tumor volume remained a the most significant correlate. The correlation coefficients for both methods only indicate moderate to low positive correlation.
Additionally, the average gamma pass rates for the diode array were 3.7%, 5.4%, and 14.5% higher than the EPID gamma results for the gamma criteria of 3%/2 mm, 2%/2 mm, and 2%/1 mm, respectively. This may indicate that diode array-based QA may be more lenient in terms of passing gamma criteria compared to EPID-based QA.

Conclusion(s):

Though no major correlation for different clinical factors on gamma analysis pass rates was found, this study demonstrates that both EPID-based and diode array-based QA methods are valuable tools for SRS treatment verification. However, the choice of method may depend on various factors. EPIDs offer the advantage of being readily available and integrated into the treatment workflow, making them a convenient option for daily QA.
Diode array-based QA systems can provide higher spatial resolution and may be more representative of the actual dose delivered to the patient, as they are often placed in a phantom that mimics the patient's anatomy. However, setting up and using a diode array phantom can be more time-consuming and complex.
The choice between EPID-based and diode array-based QA should be made considering the specific clinical needs and available resources. In some cases, a combination of both methods may be beneficial to ensure comprehensive QA coverage.