PATIENT-SPECIFIC QA FOR CYBERKNIFE USING A PORTABLE FLAT-PANEL IMAGER

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Purpose: Currently, the CyberKnife InCise MLC system delivers fields using a static-leaf configuration. Before dynamic MLC deliveries can be introduced, development of a high-resolution (spatial and temporal) detector is required for adequate patient-specific QA (PQA). This study describes a PQA acquisition of an InCise-collimated CyberKnife plan using the QA StereoChecker (QASC, Standard Imaging Inc., Middleton, WI); a high-speed, high-resolution portable flat-panel detector. While providing filmless PQA, the temporal resolution (200ms) of the QASC allows for analysis of individual beam segments and dynamic MLC plans once introduced.

Methods: An empirically-derived fluence-to-dose conversion was applied to images of individual beams with diameters of 7.5mm, 30.0mm, and 60mm. A PQA plan was generated in the treatment planning system (TPS) for an 83-segment prostate plan. Following fiducial-based automated alignment of the QASC with the CK's target localization system, the plan was delivered from a nominal position orthogonal to the detector. Images were converted to dose and compared with dose distributions calculated by the TPS.

Results: Profile analysis of the circular fields showed that measured and planned values agreed well in the primary, shoulder, and penumbra regions of the beam. In the tail, the QASC underestimated dose, and an overcompensation algorithm was used to mitigate the over-response of higher pixel intensities resulting from photoelectron contamination originating from the amorphous silicon substrate. This overcompensation was visible when analyzing planned segments or composite images, however if analyzed with a 20% threshold, this effect was eliminated. The gamma passing percentage for the PQA, using a 2%/2mm criteria, was 98.5%. Images could be acquired every 200ms.

Conclusion: Following a dose-to-pixel value correlation, the QASC adequately and efficiently performed patient-specific QA. The high acquisition rate allowed for separate analysis of each segment, which can be applied to QA of dynamic MLC plans in the future.

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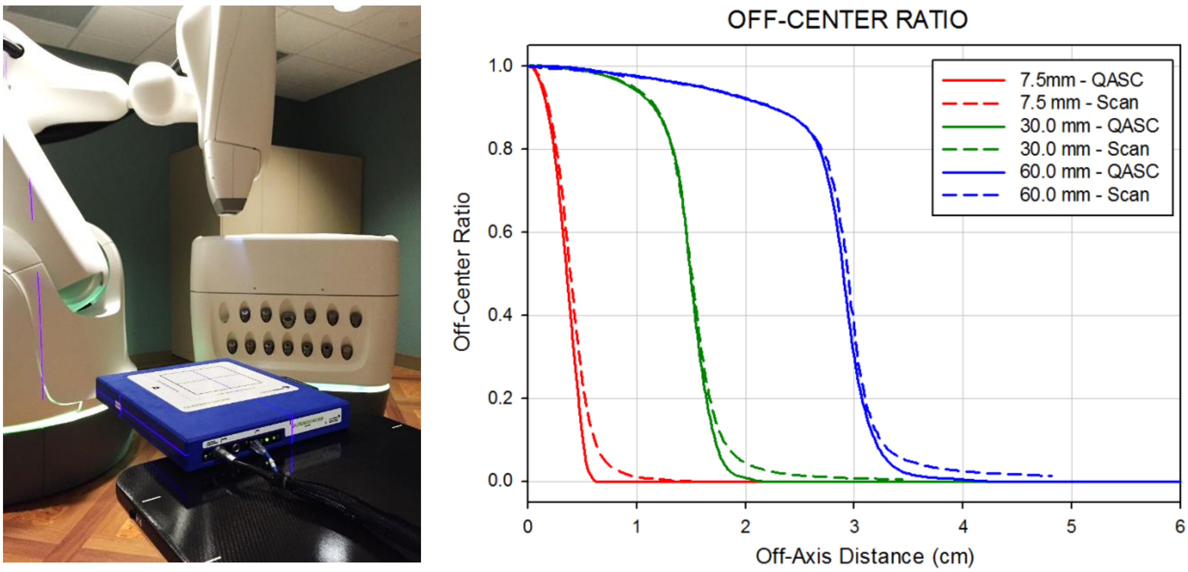

FIGURE 1: ***Left.*** The QA StereoChecker, a portable flat-panel imager, is automatically aligned using the treatment localization system of the CyberKnife. ***Right.*** Comparison of individual circular fields acquired with the QA StereoChecker (and converted to dose using an empirically-derived fluence-to-dose conversion). QA StereoChecker profiles were compared to those acquired using an ionization chamber in a scanning water tank. The lower measured dose in the tail region has no observable effect on analysis when the threshold-of-analysis is set to 20% of the maximum dose.

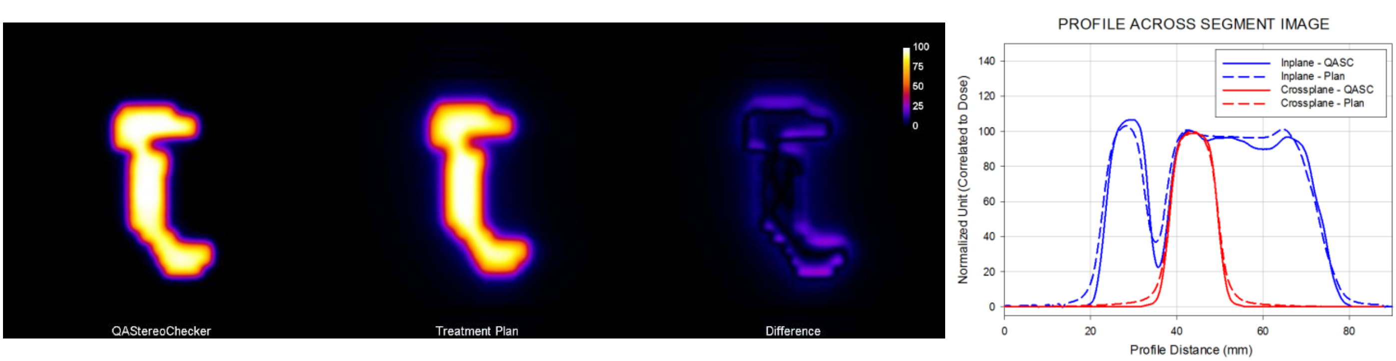

FIGURE 2: Comparison of planned and acquired planar distributions for a single segment of an 83-sement prostate plan collimated with an InCise MLC system.

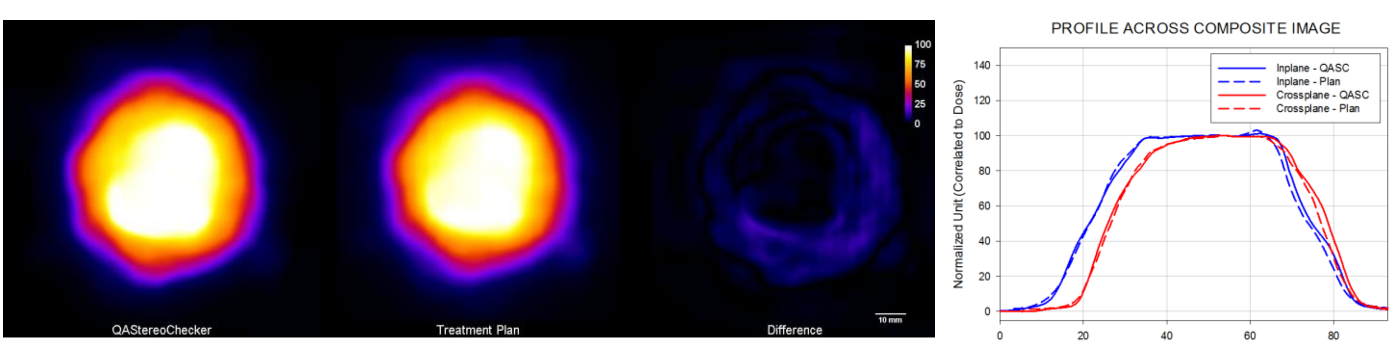

FIGURE 3: Comparison of planned and acquired planar distributions for an 83-segment prostate plan collimated with an InCise MLC system.