

Comparison and Assessment of Profile and Output Factor Measurement for a CyberKnife System Using Different Detectors

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Abstract

Objectives: To compare and assess different detectors for the profile and output factor (OF) measurement for a CyberKnife system, and provide reference and suggestions for selecting and using the correct detectors.

Methods: Profiles were acquired using the detectors of PTW-60017, PTW-60018, PTW-60019 and IBA-SFD, at different depths for different collimator sizes, with the detectors stem oriented both perpendicular and parallel to the central beam axis. The differences of profiles among different detectors and orientation of detectors were analyzed. Output factors were measured using PTW ionization chamber 30013, 31010, diode detector PTW 60017, PTW60018 and diamond detector 60019 for different fixed aperture collimators from 5 mm to 60 mm at SAD 800 mm and depth of water 50 mm. EBT3 film measured OF at 5 cm depth in a water phantom with a SAD of 800mm was used as reference for comparison.

Results: All full width at half maximum (FWHM) of field measured by four detectors in parallel orientation were larger than actual field size. The deviation increased with the size of collimator and measurement depth, with the maximal deviation of 0.6mm. The deviation of FWHM among four detectors increased with the increase of measurement depth, with the maximum deviation of 0.2mm. The penumbra was the smallest for IBA-SFD, and largest for PTW-60019. The maximal deviation of penumbra was 0.3mm. The IBA-SFD agreed with other detectors but tended to over-respond in the out-of-field region when the collimator size was larger than 30mm. Both FWHM and penumbra in perpendicular orientation were smaller than in parallel orientation for PTW-60017, PTW-60018 and PTW-60019, especially for the 5mm collimator. However, the trend was opposite for IBA-SFD. With the increase of collimator aperture, the difference between the right and left penumbra acquired by four detectors increased, with more obvious stem effects observed. A good agreement among the output factors obtained from these five detectors was found for the collimator size more than 30mm, with the deviations less than 1%. When the collimator size was less than 30mm, the deviations of the OF became large and obviously increased with the decrease of the collimator size. The measured OFs of PTW60019 were basically consistent with EBT3 film, with the deviation less than 2%. The OFs were higher for diodes detectors, and much smaller for Ionization chambers than EBT3 film.

Conclusions: Similar profiles were acquired by PTW-60017, PTW-60018, PTW-60019 and IBA-

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Abstract

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SFD, but the detectors' characteristics and effects of detector orientations should be considered. PTW 30013, 31010, PTW 60017, PTW60018 and 60019 could be directly used for the OFs measurement, when field was greater than 30mm. But if the field was less than 30mm, the measurement results obtained by these detectors need to be corrected. Sensitive volume, the effective measure length and material density of detector affected the measurement of OFs, especially for small field.