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CyberKnife Preliminary Commissioning Model for a Twinned Beam

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Purpose
To establish a beam twinning procedure and develop a model for accelerated TPS commissioning for all three collimators of CyberKnife M6 & S7 models.

Methods
Beam twinning was performed in two phases: initially with PTW Octavius 1000 SRS 2D panel with real-time feedback, then in 3D water tank with PTW SemiFlex 3D 0.3 cc chamber for cone-60 (0-300 mm PDD, 50 mm profiles) and the primary beam (50 mm profiles). Gamma matching against the twinning reference comprised: PDD 1mm/1% local, profiles 1mm/0.7% global.
10 linacs were twinned, then fully commissioned using PTW microDiamond with independent sets of fixed, Iris and MLC collimators. For each linac, all 35 beams (FS 5-115 mm) were measured for: TPR, dose profiles at 15, 100 and 300 mm depth, output factors (OF).
The commissioning data were analyzed to develop a model for each of 35 beams with respect to OF, TPR, profiles. Each linac was tested against this BDI model using strict and relaxed matching criteria.

Results
Commissioning was greatly accelerated with PTW BeamScan tank and took 32 hrs/linac.
Comparing each of 10 linacs vs the model, OF showed: FS 10+ mm 0.3%/0.5% (RMSE/max) errors, two smallest FS (5, 7.5 mm) > 0.5% errors.
For TPR, gamma 1 mm/1% local in 0-200 mm, and 1.5% local in 200-300 mm passed 95+%.
For profiles the following gamma passed 95+%: for cones & Iris, 0.3/0.6 mm (small/large FS), 0.5%, 0.7%, 1.5% global (15, 100, 300 mm depth); for MLC, 0.3-1 mm (smallest-to-largest FS), 1%, 1%, 1.5% global (same depths).

Conclusion
Preliminary model provides strict beam control deemed to be acceptable for SRS/SBRT.
Two linac failures for energy twinning called for manufacturing improving. Iris radiation FS calibration, similar to MLC, can reduce its data variance.

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