Purpose/Objective(s): With on-board cone-beam CT (CBCT) guidance, invasive head frame is no longer necessary for target localization in the linac-based SRS procedure, but should be retained for rigid immobilization at time of treatment. The procedure allows pre-treatment plan optimization. In this effort, we investigate combining CBCT guidance with VMAT to achieve accurate and efficient SRS of multiple brain metastases.

Materials/Methods: Planning studies of a case with two brain metastases were used to compare VMAT with Gamma Knife (GK) and IMRT deliveries. A single, 356° dynamic VMAT plan was generated using the prototype SmartArc feature in the Pinnacle treatment planning system. The corresponding GK and 8-field IMRT plans were also created. All plans prescribed 18 Gy to the PTV. The GK plan was normalized to 50% with 0mm PTV expansion. The VMAT and IMRT plans were normalized to 80%, with 3mm GTV to PTV expansion. A head phantom with an imbedded 9/16 in diameter steel-ball target was used to test delivery accuracy. CT-simulation and treatment planning of the head phantom was performed with Pinnacle. A virtual frame representing the invasive frame as a 3D-surface mesh was used to optimize frame location and to minimize beam interference. The real frame was then placed on the phantom according to the plan coordinates. CBCT-guided positioning of the head phantom on the linac was performed with a couch capable of motion with 6 degree of freedom (6DOF). Eight MV localization images were exposed with a 24mm x 24mm open-field at 4 orthogonal and 4 no-coplanar gantry angles. The displacement vector between the centers of the square field and the ball target on each portal image was used to quantify delivery accuracy.

Results: Satisfactory coverage of the two PTVs was achieved for all plans with a Dmin of 19.8Gy, 17.1Gy and 19.6Gy to the GTV for VMAT, GK and IMRT, respectively. The conformality index for the VMAT, GK and IMRT plan were 1.28, 1.93 and 1.29, respectively. The VMAT plans were delivered in 6.6mins. It took greater than 1 hour for the GK plans and 30mins for the IMRT plans. The virtual frame tool aided effective frame placement to minimize beam interference. The actual frame did not introduce serious artifacts on the CBCT images. End-to-end tests of the entire procedure show a target can be irradiated to within 1.5 mm of the planned delivery.

Conclusions: With VMAT, SRS treatment of multiple brain mets can be performed with a single isocenter in less than 10 mins. Our virtual frame tool allows treatment optimization prior to the day of treatment.Immobilization with the invasive frame ensures highly accurate radiation delivery and also eliminates the need for frequent treatment interruption to monitor or correct intra-fraction motion.

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