Dose Agreement Dependence on Chamber Orientation in Quality Assurance (QA) for Stereotactic Radiosurgery

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Objectives: In CyberKnife® (Accuray - Sunnyvale, CA) radiosurgery plans created to treat brain lesions, orienting the ion chamber across the couch instead of longitudinally has been observed to sometimes yield closer agreement between the dose predicted by the planning system (Precision, Accuray - Sunnyvale, CA) and the dose measured during QA. Methods were developed to test the hypothesis that dose agreement in QA conducted with a certain orientation of the A16 Standard Imaging (Middleton, WI) chamber is related to the proportion of measured radiation incident posterior to and delivered by beams directly intersecting the chamber.

Methods: Individual beams were delivered to a chamber from various angles and the resulting depth-corrected dose calculated from electrometer readings were compared. For seventeen SRS treatment plans, patient specific QA was conducted with the chamber oriented along and across the couch, and measurements were converted to dose using a transfer factor calculated at the time of TG-51. Next, dose agreement resulting from both orientations were compared. For each treatment plan, the proportion of planned monitor units delivered by beams that intersected the chamber thimble was recorded. In six SRS treatment plans, a new isocentric beam set was generated to control for directly intersecting dose. QA was conducted for these plans with the chamber oriented along and across the couch (for a total of twelve plans) and the depth-corrected dose from each beam was recorded. Additionally, in four plans, the angles of beams that delivered monitor units were analyzed.

Results: Data showed that the A16 ion chamber has little angular dependence, except when radiation is delivered from a point 45o from a direction posterior to it. Irradiation from such a point produces a result lower by 1.1% than when delivered from a perpendicular direction. Orienting the chamber across the couch during QA improved dose agreement in four out of seventeen non-isocentric plans, suggesting that there many situations in which this orientation is not optimal. In plans in which QA dose agreement improved with the chamber crosswise, the proportion of monitor units directly intersecting the chamber appeared to have a stronger correlation with improved dose agreement in QA conducted with the chamber along the couch than in QA conducted with the chamber across the couch, though the significance of these results could be further evaluated by using larger samples. In the isocentric plans, correlation coefficients calculated for a proposed relation between the distribution of irradiation angles and dose agreement suggest that agreement is improved by delivering a smaller proportion of monitor units from behind the chamber and a larger proportion from the front and side. In isocentric QA conducted with the chamber oriented across the couch, beams originating posteriorly to the chamber were slightly overrepresented in the group of beams delivering the lowest dose, after corrections were made for SAD and phantom depth.

Conclusions: The results suggest that dose agreement in QA plans with a given chamber orientation might be predicted by incidence angle and proportion of beams that intersect the chamber.