Tomotherapy and stereotactic radiosurgery

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Currently, at the University of Wisconsin-Madison, a linear accelerator equipped with circular collimators and a floor stand is used for stereotactic radiosurgery (SRS) delivery. In the interest of providing a more efficient delivery option for patients with multiple brain metastases, a Tomotherapy-based radiosurgery program was developed to serve as an intensity modulated compliment to our existing delivery method. The unique advantage of Tomotherapy over other radiotherapy delivery units is the on board megavoltage CT that can be used for both stereotactic localization and treatment planning. As such, a workflow was designed in which the planning image is acquired on the treatment unit itself and, instead using a patient-frame based coordinate system for stereotactic localization, volumetric imaging is used to precisely locate the target at the time of treatment. Localization and delivery accuracy was found to be comparable to conventional approaches and well within stated tolerances. A Tomotherapy-specific treatment planning technique was also developed using the Tomotherapy treatment planning system that reliably produces plans that achieve both conformal target coverage and sufficiently steep dose falloff into surrounding normal brain. Tomotherapy plans have been compared to conventional circular collimator based plans for both the treatment of brain metastases and arteriovenous malformations in terms of both target conformity and dose to normal brain. To determine the effect of plan differences on patient outcome, clinical data was used to predict the resulting risk of treatment induced symptomatic brain necrosis for both conventional and Tomotherapy based plans. Overall, it was determined that plans generated using the described planning technique are acceptable for radiosurgery. In addition, delivery time for complex cases is comparable to or improved over conventional isocentric approaches. Finally, this work explores the impact of future product developments on the accuracy and efficiency of Tomotherapy based radiosurgery. The testing methodology described throughout this work could also be used to evaluate other novel radiosurgery approaches.