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Feasibility of novel LINAC-based VMAT technique for functional stereotactic radiosurgery

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Abstract

Objectives: Gamma Knife (GK) has been an effective tool for functional stereotactic radiosurgery (SRS) of a variety of neurological conditions. These include facial pain syndromes, movement disorders, thalamic pain, obsessive compulsive-disorder, and intractable pain associated with end stage metastatic malignancy. The intent of this study was to determine if GK dosimetrically similar plans could be generated using frameless, MLC-based (virtual cone) volumetric modulated arc therapy (VMAT) SRS for the following treatments:-Ventral intermediate nucleus (VIM) thalamotomy for essential tremor-Subthalamotomy for Parkinsonian tremor-Anterior capsulotomy for obsessive compulsive disorder -Sphenopalatine ganglion (SPG) ablation for atypical facial pain-Pituitary stalk hypophysectomy for intractable end-stage metastatic pain-Centromedian thalamotomy for central pain syndrome-Pallidotomy for medically refractory Parkinsonian tremorThis approach is currently being studied at our institution for trigeminal neuralgia in a clinical trial.

Methods: The appropriate anatomical structures outlined above were contoured within a treatment planning system by an experienced radiation oncologist and reviewed by a neurosurgeon and neurologist in a 3T MR sequence. Prescription doses and target selection for each treatment type were designated based on previously published experiences with GK. GK treatment was simulated in Gamma Plan with 4-mm collimator. VMAT treatment was simulated within Eclipse using an MLC-based virtual cone based approach previously developed to replicate GK dosimetry for trigeminal neuralgia treatments. Plans were reviewed for acceptability by the multidisciplinary team. Gradient measure, V12Gy, and mean brain dose were also compared for each case between the two delivery systems.

Results: For each case, the LINAC approach was able to generate a plan nearly dosimetrically equivalent to its GK counterpart, and to metrics previously reported in the literature. For each case, between GK and VMAT, gradient measure was within ± 0.1cm, V12 was within ±4cc, and mean skull dose was within ±40cGy.

Conclusions: With stalwart patient positioning considerations, dedicated intrafraction motion monitoring, and robust quality assurance measures, coneless MLC-based VMAT on a linac is a feasible option for SRS of functional neurological conditions.

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