Spatial Variations of Multiple Off-Axial Targets for a Single Isocenter SRS Treatment Plan in ExacTrac 6D Robotic Couch System

Sangroh Kim, PhD
Medical Physicist
Genesis Cancer Care Institute
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Stereotactic Radiosurgery

• **Stereotactic radiosurgery** (SRS) is a form of radiation therapy that focuses high-power radiation energy on a small area of the body. Despite its name, SRS is a treatment, not a surgical procedure. Incisions (cuts) are not made on your body
  (http://www.nlm.nih.gov/medlineplus/ency/article/007274.htm)

• SRS can be performed using GammaKnife, CyberKnife or Linear Accelerator system
GammaKnife
Linac Radiosurgery
CyberKnife
BrainLAB ExacTrac System
Triology w/ ExacTrac System at Genesis
How LINAC Radiosurgery Works
Innovation/Impact

• SRS QA - Winston/Lutz (W/L)Test
  – To assure accurate treatment deliveries for SRS treatments
  – Radiation isocenter matches to the mechanical isocenter within sub-millimeter accuracy

• Volumetric modulated arc therapy (VMAT) for tx of brain metatheses sparsely located in multiple positions w/ a single isocenter treatment plan
  – W/L test may not be sufficient to assure the accuracy of tx delivery
Winston/Lutz Test
VMAT Plan for Multiple Brain Mets
Methods

• Five metallic ball bearing (BB) markers were placed sparsely in 3D off-axial locations (non-coplanar) inside a skull phantom
  • Representatives of multiple targets mimicking multiple brain metastases
  • Locations of the BB markers were carefully chosen to minimize overlapping of each other in a port imaging detector plane (PortalVision, Varian Medical System)

• The skull phantom was immobilized by a frameless mask and CT scanned w/ a BrainLab Head&Neck Localizer using a GE Optima MDCT scanner
Methods

• The CT images were exported to iPlan software (BrainLab AG) and a multiple target PTV was drawn by combining all the contours of the BBs
  • The margin of the MLC opening was selected as 3 mm expansion outward. Four non-coplanar arc beams were placed to generate a single isocenter SRS plan to treat the PTV

• The arc beams were delivered using Novalis Tx system with portal imaging acquisition mode per 10% temporal resolution

• The locations of the BBs were visualized and analyzed with respect to the MLC aperture in the treatment plan similar to the Winston-Lutz test.
Skull phantom with 5 metal BB
CT Scanning
Dynamic Arc Delivery w/ EPID
Results

• All the BBs were clearly identified inside the MLC openings
• The positional errors for the BBs were overall less than 1 mm along the rotational path of the four arcs
• This study demonstrated that the ExacTrac system can precisely localize the multiple target PTV in 3D space with sub-millimeter accuracy
• Accompanied with the Winston-Lutz test, this test will quality-assure the spatial accuracies of the isocenter and the locations of multiple targets for the SRS treatment using a single isocenter multiple target treatment plan
Arc 1 - Plan
Arc 1 - EPID
Arc 2 – Plan
Arc 2 - EPID
Arc 3 - Plan
Arc 3 - EPID
Arc 4 - Plan
Arc 4 - EPID
Thank you very much!