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Abstract
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Techniques and Workflow for Linac Based Frameless Stereotactic Radiosurgery for Uveal Melanoma

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Abstract

Objectives:

Varian Truebeam Stx linear accelerator with BrainLAB ExacTRAC stereoscopic dual-xray image guidance system are commonly used for LINAC-radiosurgery. Although ExacTRAC system can provide accurate patient setup correction and verification at all couch angles, the image registration is purely base on bony anatomy of patient’s head but cannot track patient’s eye movement during treatment. Therefore, a novel in-house eye localization/monitoring device was developed and implemented in clinic for the fractionated stereotactic radiosurgery for uveal melanoma at our institution. This study aims to describe technical development and clinical workflow including simulation, planning and treatment delivery for 23 patients treated from 2017 to present.

Methods:

The localization box was designed and fabricated with an Ultimaker-S5 3D-printer. This device is compatible with the BrainLAB frameless SRS and ExacTRAC system to achieve accurate head setup and flexible positioning of a LED lights as a gaze focus point and CCD camera for video monitoring of the patient’s eye position during treatment. The thermoplastic immobilization mask was cut to reveal the motion of the patient’s treated eye. This cut ensures that the camera can detect eye motion. Patients were CT simulated with the localization box and coaching to staring at the light during CT acquisition. Treatment plan was developed using iPLAN Dose version 4.5, with conformal dynamic arcs technique and 6MV photon beam in flattening filter free mode. Prescription dose is 50 Gy in 5 fractions. 4~5 arcs were used for each plan in order to achieve conformal dose distribution and reduce the number of MU for each arc, so that the treatment time for each arc can be reduced. ExacTRAC system was used for patient setup, the residue errors were recorded and reported. For the first fraction of each patient’s treatment, a Cone-beam CT was acquired while patient was under eye-staring coaching to verify the orientation and location of the optic nerve and the treating eye to be consistency with the planning CT. Physician visually verified the image registration with special attention on the optic nerve and eye on the treating side. During treatment, patients were instructed to staring at the light when a radiation beam is prepared and ready for delivery, and were instructed to relax after each arc delivery. Eye movement was tracked through CCD camera through entire treatment and the radiation can be manually shut off if the patient eye movement is out of set tolerance. Maximum MU per arc in each plan and maximum delivery time for each arc were recorded and reported.

Results:

The localization box was 3D printed with polylactic acid (PLA) material, which has an electron density of 1.06 and an attenuation factor of 0.95. It was attached to the BrainLAB frameless SRS system. It allowed for successful flexible positioning of the camera and LED lights in both lateral and longitudinal directions. 23 patients were treated at our institution since May 2017 to present. For these patients, the maximum MU per arc in each patient plan is 404 ± 54 (range 321 ~ 541), and the maximum treatment time for each arc is 17.3 ± 2.4 seconds (range 13.8 ~ 23.4). All patients eye position was stable under light-staring coaching during radiation delivery (less than 24 seconds). After EaxcTRAC IGRT setup, the residue setup errors are -0.1 ± 0.3 mm laterally, -0.1 ± 0.3 mm longitudinally, and 0 ± 0.2 mm vertically. The residue rotational errors are -0.1 ± 0.3 degree pitch, 0.1 ± 0.2 degree roll, and 0 ± 0.2 degree couch rotation.

Conclusion(s):

A 3D-printed device was designed and made to use in conjunction with the institutional existing platform

for LINAC-SRS for treating uveal melanoma or other orbital tumors. Clinical follow up with early patients demonstrated favorable local control with limited toxicity. Detailed clinical outcomes are reported separately as an abstract and presentation to this meeting.