Distal Gradient Tracking (DGT) for Ion Beam Radiation Therapy

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Technology description

External beam radiation therapy is a tumor treatment technique that directs one or more high-energy radiation beams to the tumor. Advanced external beam radiation systems treat tumors with multiple X-ray fan beams that can be rotated around the patient. Each beam consists of individual "beamlets" whose intensity can be controlled to allow for the treatment of complex tumor shapes. However, X-ray energy still is deposited to all tissue along the entire path of the beam up to the exit point.

An alternate beam radiation therapy technique involves the use of ions such as protons to treat tumors. This technique dramatically reduces the radiation dose to healthy tissue when compared with X-ray radiation therapy using photons. The dose intensity from protons is not uniform along the beam path and rises to a "Bragg peak" near a point where the proton beam stops completely. Controlling the placement of the Bragg peak so it is located on the tumor reduces the amount of radiation delivered to the patient's healthy tissue. Unlike X-ray radiation therapy, ions allow for separate control of the total dose of radiation (intensity) and distance the Bragg peak occurs (range).

Digital Edge Tracking (DET) is a proton beamlet placement process in which the Bragg peak occurs at the point that the beam axis exits the tumor. This process applies a homogeneous dose of ion radiation to the target tumor. However, the treatment of certain tumors can benefit from a non-homogeneous dose tailored to the specific tumor. UW–Madison researchers have developed an ion radiation treatment system that places the Bragg peak according to a prescribed dose plan to impart non-homogeneous radiation doses to the tumor area. Basically, the Bragg peak is placed at a point where the prescribed dose value falls under a certain level in a dose gradient. Each gradient is specific to the angle that the beam is being applied to, and thus is tailored to the specific tumor.

The system consists of an ion beam source and a range controller. A separate beam controller executes a stored radiation plan in conjunction with a dose plan that defines the region where the dose is to be applied to determine the beam gradients for every angle at which the ion beam is applied. The beam controller sends control signals to the range controller to position the Bragg peaks according to the gradients.

Application area

External ion beam radiation therapy for treatment of tumors

Advantages

Decreases the amount of proton beamlets needed
Allows for tailored dose prescriptions inside the tumor
Increases treatment speed

Institution

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