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RESEARCH

May 27, 2009

Protons of benefit for prostate cancer

Long-term survivors of prostate cancer who were treated with radiation therapy face a small but significant risk of developing radiation-induced secondary cancer. Many of these second cancers arise in the normal tissue adjacent to the target, thus it's been suggested that proton therapy - with its dosimetric advantages - could potentially reduce their incidence.

Studies have suggested that using spot-scanned proton therapy for prostate irradiation can reduce the incidence of second cancers compared with intensity-modulated radiation therapy (IMRT). However, as most clinical centres currently use passively scattered proton delivery, for which the production of stray neutron radiation has become a concern, it's important to investigate this option also.

Following on from recent studies of the second-cancer risks of paediatric craniospinal irradiation (Protons promise lower second-cancer risk), Jonas Fontenot and colleagues at the MD Anderson Cancer Center (Houston, TX) have now assessed the relative risks of treating prostate cancer with passively scattered protons and 6-MV IMRT. The studies accounted for contributions from both primary and secondary sources of radiation (*Int. J. Radiat. Biol. Oncol. Phys.* **74** 616).

"There is a raging debate about whether proton therapy should be used to treat prostate cancer," explained Wayne Newhauser, from MD Anderson's department of radiation physics. "The argument against proton therapy basically reasons that the outcomes are similar to those achievable with other modalities, but the cost of proton therapy is higher. That argument failed to take into account the cost associated with radiogenic second cancers."

Newhauser notes that this debate is particularly important due to the high incidence of prostate cancer, as well as the fact that around 60% of the proton-therapy capacity in the USA is currently devoted to treating patients with this disease.

Risk assessment

To compare the two techniques, the researchers used a commercial treatment-planning system to construct proton therapy and IMRT plans for three patients with early-stage adenocarcinoma of the prostate. The plans were used to calculate the absorbed doses from the primary field in adjacent organs-at-risk. Secondary doses were determined using Monte Carlo simulations for proton therapy and available measured data for IMRT.

Both treatments provided adequate coverage of the target volume and margins, with the proton therapy plan offering slightly greater dose uniformity. Both also provided acceptably low doses to surrounding critical structures. However, proton therapy delivered substantially lower doses at low and intermediate levels in the bladder and rectum.

The mean and maximum doses to the bladder were 13.2 and 78.5 CGE (cobalt gray equivalent), respectively, for proton therapy, compared with 22.2 and 80.6 Gy for IMRT. For the rectum, these figures were 20.8 and 78.5 CGE for proton therapy and 28.1 and 79.8 Gy for IMRT. In general, secondary doses were smaller for proton therapy than IMRT near the primary field, but greater for proton therapy in tissue farther away.

The researchers estimated the risk of secondary malignant neoplasm due to the total doses on an organ-by-organ basis, using organ-specific risk coefficients taken from a recent report of the Committee on the Biological Effects of Ionizing Radiation. The risk was greatest in the in-field organs (bladder and colon/rectum), where the proton therapy plan resulted in considerably lower risk than the IMRT plan.

Having determined the excess relative risks of developing a radiation-induced cancer after proton therapy or IMRT, the researchers calculated the ratio of excess risk for proton therapy relative to IMRT. This ratio was 0.61, 0.66 and 0.74 for the three patients, suggesting that the proton therapy plan could reduce the second-cancer risk by 26-39% compared with IMRT.

The MD Anderson team concluded that, despite the secondary neutrons, passively scattered proton therapy reduces the projected incidence of radiogenic second cancers in prostate-cancer patients.

They highlight the finding that risks associated with proton therapy are predominated by the primary beam, not the stray neutron radiation, as particularly noteworthy, given the considerable debate surrounding neutron production during proton therapy. The results do, however, also imply that reducing stray radiation exposures - via beam scanning or

local shielding techniques - can lower the second-cancer risk further.

About the author

Tami Freeman is Editor of *medicalphysicsweb*.