Radiation therapy algorithm could reduce side effects, maintain effect against tumors

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Researchers at North Carolina State University have developed a mathematical model for computing radiation therapy treatments that could substantially reduce patient side effects while delivering the same results as conventional radiation therapy.

Cancer patients who receive radiotherapy to destroy their tumors are given a total dose of radiation split into multiple equal treatments delivered over days or weeks. This is due to something called the fractionation effect: radiation-induced cell damage is lower if the same physical dose is delivered in multiple fractions, because it allows healthy cells to recover between treatments. Current clinical protocols stipulate that patients receive the same dose in each treatment session, every day.

But do the doses have to be the same each day? "Different doses, carefully planned to minimize side effects, can be just as effective," says Dávid Papp, assistant professor of mathematics at NC State University. "However, the extent of this benefit has never been assessed. The algorithms we use now to determine the best personalized treatments don't work when computing treatments with different dose distributions in different fractions."

Papp set out to develop and test a so-called "spatiotemporal fractionation" approach that would reduce the radiation dose to healthy tissue while maintaining effectiveness against the tumor. In a proof-of-concept study, Papp tested the plan against model slices of five different liver tumors, each representing a unique tumor size or location to allow comparisons with actual clinical treatments.

"We wanted to see what the quantitative benefits of such a new protocol would be," says Papp. "How much can you reduce the radiation's effect on the liver while making sure that the tumor receives a consistent and effective dose? A reduction of 20 percent would reduce side effects enough to warrant a change in everyday clinical practice."

Papp's model reduced the liver dose by 13 to 35 percent without compromising other clinical goals. He has begun work on refining the model to make it more robust, with a view toward in vivo testing.

"Conventional radiation treatments don't necessarily achieve maximum benefit," Papp says. "Our protocol, by delivering a high single-fraction dose to parts of the tumor during each fraction and a consistent lower dose to the liver and other healthy tissue, could reduce patient side effects substantially while maintaining the same effectiveness as conventional treatments."

The research appears in *Physics in Medicine and Biology*. Papp is corresponding author.

More information: Melissa R Gaddy et al, Optimization of spatiotemporally fractionated radiotherapy treatments with bounds on the achievable benefit, *Physics in Medicine & Biology* (2018). DOI: 10.1088/1361-6560/aa9975

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