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“Knowledge-based planning and treatment decision-making for gynecologic brachytherapy”

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SCIENTIFIC ABSTRACT

Brachytherapy is an essential component of cervical cancer treatment, and image guidance enables applicator, needle placement and source positioning to be tailored to an individual patient's anatomy. Currently clinicians must rely on their experience, clinical exams, and outdated images to make subjective decisions about applicator type and needle placement. Consequently, brachytherapy implants are highly variable and can result in suboptimal tumor coverage or increased dose to organs-at-risk. In addition, the treatment process is complex and treatment planning is inefficient, which is likely leading to the decline in brachytherapy usage globally and a reduction in patient survival. Unlike current brachytherapy practice, external beam radiotherapy is benefiting from machine learning methods that automate, standardize and improve treatment planning through a technique known as knowledge-based planning. Unfortunately, application of knowledge-based techniques to gynecologic brachytherapy remains unexplored. The goal of this work is to develop machine learning-based models, which use imaging data prior to brachytherapy to predict dosimetric parameters and optimal applicator design so that clinicians can be informed prior to entering the operating room. CT imaging and dosimetric data from 120 previously treated patients will be used to train a machine learning model. Geometric/anatomic variables computed from contours of tumors and organs-at-risk will be correlated to dosimetric outputs (e.g. max dose to organs-at-risk). Then, dosimetric outputs will be used to classify patients according to optimal applicator and/or use of needles. Accurate patient-specific predictions will facilitate automated brachytherapy treatment planning and quantitative decision-making for cervical cancer, improving brachytherapy quality and accessibility worldwide.

LAY ABSTRACT

Brachytherapy is a treatment in which radiation is delivered internally, using a device known as an applicator and/or needles to guide a radioactive source directly into the tumor. Using imaging, this radiation dose can be customized to an individual patient’s anatomy, maximizing dose to the tumor while minimizing dose to healthy organs. Although brachytherapy is an essential component of cervical cancer treatment, centers worldwide are offering less and less brachytherapy. This could be because the treatment process is complex, time consuming, and requires a very skilled team. Doctors use their experience to decide what applicator and needles to use, and physicians with deep brachytherapy experience are a scarce resource. Machine learning is an exciting new technique where large amounts of data are input into advanced computer models to automatically make predictions. In this study, we will use data from hundreds of prior patients’ treatments to make predictions for an individual patient. The machine learning model will be able to look at images of a patient before brachytherapy, and then predict the best applicator for that patient, as well as the radiation dose he/she will receive. This will help doctors make important decisions about a patient’s brachytherapy treatment before they ever enter the operating room! Without brachytherapy, the chance of survival of a cervical cancer patient is reduced by 12%. The tools developed in this study will improve the quality and efficiency of brachytherapy treatments, so that brachytherapy can be used by

more centers worldwide.