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Perspective

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Study of the Stiffness of Tissues over Time during Radiotherapy Treatment Applied to Breast Cancer

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Abstract:

Introduction: The fight against cancer is often hampered by the physical resistance of tumors and the collateral damage caused by treatments. Every year, several million people are treated with radiotherapy, a treatment that uses radiation to destroy cancer cells. In Canada, breast cancer remains the leading cause of death for women between the ages of 35 and 55, where the risk of reoffending ranges from 10% to 40% over 15 years. The difficulty of radiotherapy lies in the destruction of tumor cells while sparing the surrounding healthy tissue. The mechanical properties of tumors differ substantially from normal tissues, in particular by the collagen content and extracellular matrix. In addition to being a marker of malignancy, tumor stiffening can promote the proliferation of cancer cells and the migration of metastases. Radiation treatments induce a deposition of energy (dose) causing a local modification of the mechanical properties of the tissues. The study of these properties during radiotherapy treatment would provide new information on the radio resistance of tumors, the response to treatment and the risk of recurrence.

Solution: Dynamic elastography is used to measure tissue stiffness using focused ultrasound beams. This technique could observe the evolution of the mechanical properties of the tumor zone and tissues throughout the radiotherapy treatment.

Hypothesis: We assume stiffness as a marker of changes in the microenvironment of the tumor cavity, as well as a marker in response to treatment of dosimetric planning. We assume that a tumor region with higher stiffness would respond less well to radiotherapy treatment. Conversely, a tumor with low stiffness would respond better to treatment. Alternatives for treatment planning would be proposed depending on the rigidity obtained, in particular by modifying the total dose, the dose per fraction, the number of fractions, and so on.

Methods: 10 patients with breast cancer and radiotherapy of nearly 20 fractions were selected to have 5 elastography exams, one before the 1st treatment, 3 during the treatments and one few weeks after all the treatments. Correlations will be made between the stiffness of the tumor zone/surrounding tissues and the physical factors (total dose, dose per fraction, irradiated volume), the characteristics of the patients (age, smoker, hemoglobin level, diabetes, hypertension, vascularization), the features of the tumor cavity (region, depth, volume, stage), radiobiological mechanisms and other features (tumor cavity decrease, risk of recurrence).

Results-Clinical Relevance: The study of stiffness could be a therapeutic marker in order to modulate radiation doses as a consequence of physical and other characteristics, notably by observing the progression of the mechanical properties of tumors and the inflammation of tissues during radiotherapy treatment. The use of elastography in radiation oncology would be used to adapt the treatments for each patient in order to optimize radiotherapy treatments, reduce the mortality rate, and reduce the risk of recurrence and save healthy tissue.

Biography:

Antony Bertrand-Grenier has completed his Ph.D. at the age of 30 years from Universite de Montreal in medical physics. Since 2016, he has been a Medical Physicist, a Researcher at Centre Integre Universitaire de sante et de services sociaux de la Mauricie-et-du-Centre-du-Quebec and an Associate Professor at Universite du Quebec a Trois-Rivieres. During his graduate studies, he published more than 12 papers and acquired expertise in medical imaging and radio-oncology, including elastography and radiotherapy. His research interests include introducing elastography (safely assess mechanical properties [rigidity] of tissues with ultrasounds) to diagnosis disease and treatment monitoring, image processing and optimize radiotherapy, spasticity and chemotherapy treatments.