AbstractID: 14301 Title: Assessing skin injuries with thermal effusivity imaging – A promising application for adaptive radiation therapy

Purpose:
We aim to develop an imaging-based tool to predict the patient specific risk of developing moist desquamation as a side-effect of radiotherapy, enabling targeted, timely implementation of adaptive radiation therapy (re-planning, IMRT, radioprotectors).

Method and Materials:
3-D thermal tomography (3DTT) is a technology recently developed for non-destructive, non-invasive evaluation of various materials. A mice experiment was designed to test if their 3DTT images express changes proportional to the severity of radiation-induced skin damages, before the degree of damage is externally observable. An experimental 3DTT protocol was developed to produce 15µm thick, thermal effusivity (related to specific heat and conductivity) – based images. Eleven hairless mice were irradiated to a 40Gy skin dose in a single fraction using an Ir-192 HDR source and a Leipzig applicator. Thermal effusivity images were acquired daily post-treatment. Equivalent regions of interest (ROIs) on the treated and control sides of the mice were delineated and registered from daily images. Mean thermal effusivity data for those ROIs were then compared and analyzed.

Results:
All mice demonstrated a thermal effusivity decrease in the treated area. Six mice developed moist desquamation with severe blister formation between days 11 and 14 post-radiation (high grade group) while the remainder five exhibited less severe reactions (low grade group). Larger differences in relative average effusivity between the two groups started developing 2 and 3 days post-radiation and progressive increases continued until day 5, reaching a mean of 15.6% for the high grade group and 5.1% for the low grade group. The difference between groups was significant ($p = 0.025$, Friedman test).

Conclusion:
Our pre-clinical data strongly suggest that thermal effusivity images predict the severity of radiation-induced skin injuries before they become visible. This supports their potential clinical utility for measuring individual patient's response to his/her course of treatment, and proactively adjusting accordingly.