Analyzing the effect of ionizing radiations on microcirulation

FONDAZIONE IRCCS ISTITUTO NAZIONALE DEI TUMORI

Group 8: Aurina Giorgio, Calanchi Alberto, Gamba Francesca, Schgor Pietro Filippo, Steiner Giulia

POLITECNICO MILANO 1863

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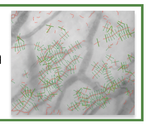
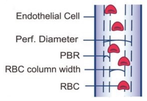
AIRC

Data collection via Glicocheck

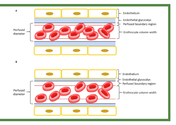


Data collection via spectrophotometer

Looking for optimal description of the microcirculation as a function of the dose, fitting ad-hoc defined functional relationships by solving minimization problems

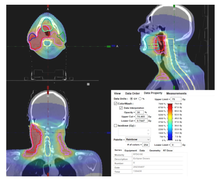


Key parameters selection, significant variables



Radiotherapy causes acute inflammation, increasing blood flow for tissue repair. Patients with higher initial hemoglobin levels experience a smaller increase in hemoglobin compared to those with lower levels

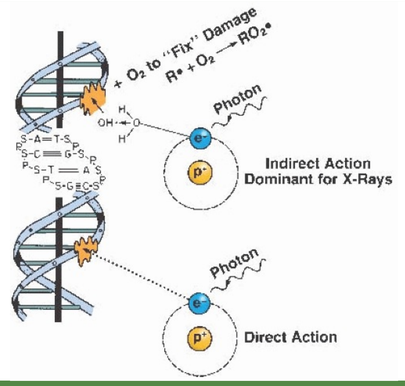
Approximation of the capillary density distribution to study how radiotherapy affects patients' health



PURPOSE

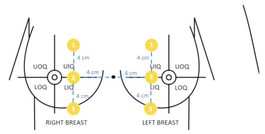
The purpose of our project is to model the effect of radiotherapy on microcirculation. We chose only a few crucial parameters to investigate in order to describe its evolution over time.

Our analysis is part of a wider investigation whose aim is to simulate the reaction of tumoral microcirculation to radiotherapy.
By now the model does not consider the variation over time.
Our research belongs to the preliminary studies that will help to make this model dynamical.

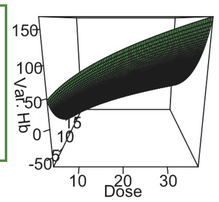


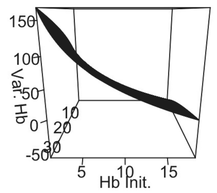
BREAST

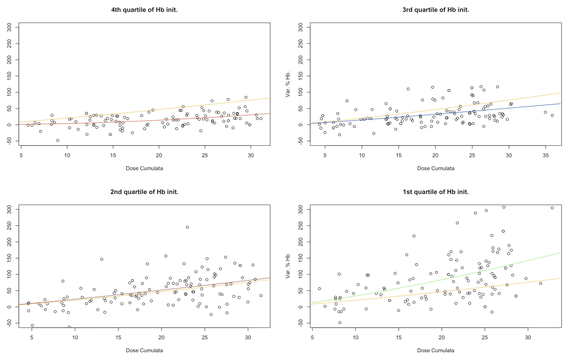
Radiotherapy induces direct and indirect tissue damage, activating a complex biological and infiammatory response, by increasing blood flow to the area to deliver more repair factors.



Patients with higher initial levels of hemoglobin already have sufficient repair factors, so their hemoglobin levels do not increase as much as in patients who initially have low levels. The latter need to increase blood flow more significantly to meet this repair requirement.







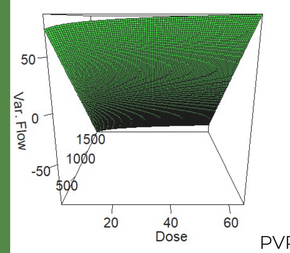
After an initial analysis, in order to describe the variation of the hemoglobin. we modeled a general non linear function that minimizes the MSE
f(x1,x2)= a*(x1)^b + c*(x1*x2)^d

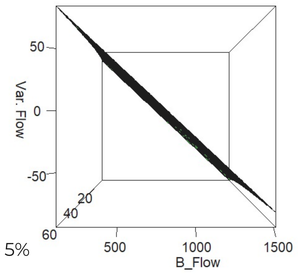
Then we used the coefficients found in the previous step to fit a linear mixed model taking into account a random effect for every patient.
This "patient level" was found to be particularly significant since we obtained a PVRE of 32% approximately.

HEAD AND NECK

The modeling of head and neck patients' microcirculation was performed by focusing on the following parameters: Total Flow, Total Density, Perfused Boundary Region. Similarly to the hemoglobin study, for each parameter we fitted a non linear function. From our results we can see that blood flow increases during radioterapy, while capillary density decreases. This can be explained by the fact that radioterapy damages blood vessels reducing capillary density, while the increment in blood flow is a synthom of the tissue repair process. As for the hemoglobin, the patients who start from higher baseline values have less significant variation in the parameters analyzed.

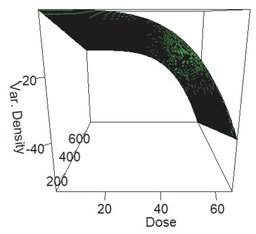
Total Flow

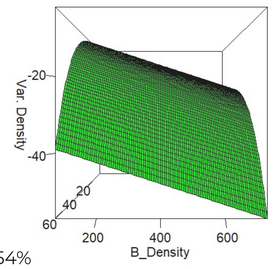




PVRE = 5%

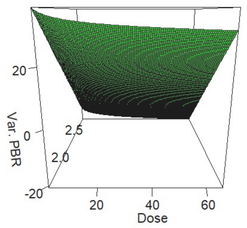
Total capillary density

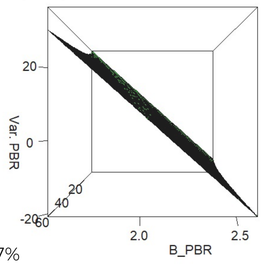




PVRE = 54%

Perfused boundary region

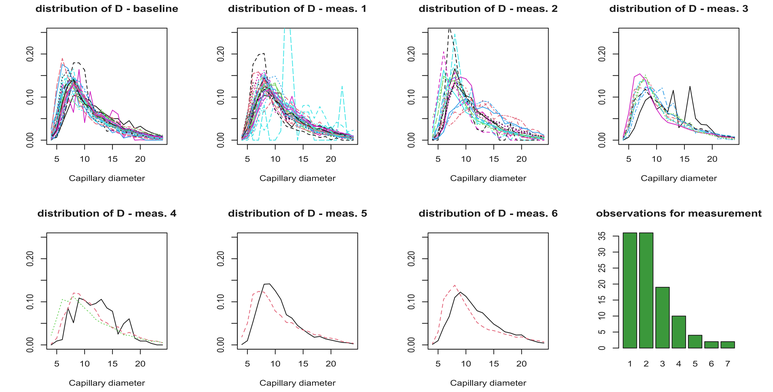




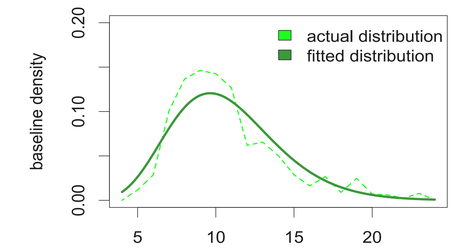
PVRE = 27%

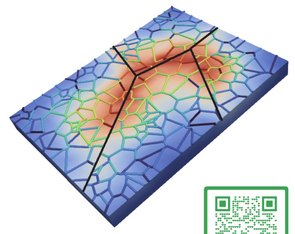
We observed that the distribution of the capillary density resembles the one of a Gamma. We modeled it throught two parameters which are a linear transformation of mean and variance.

We estimated the evolution of these parameters with a regression model. This result is particularly significant to update the modeling of microcirculation, since the distribution is required to reconstruct the geometry of the microcirculation.



gamma distribution patient 4





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