BY KATHARINA MIEDZINSKA

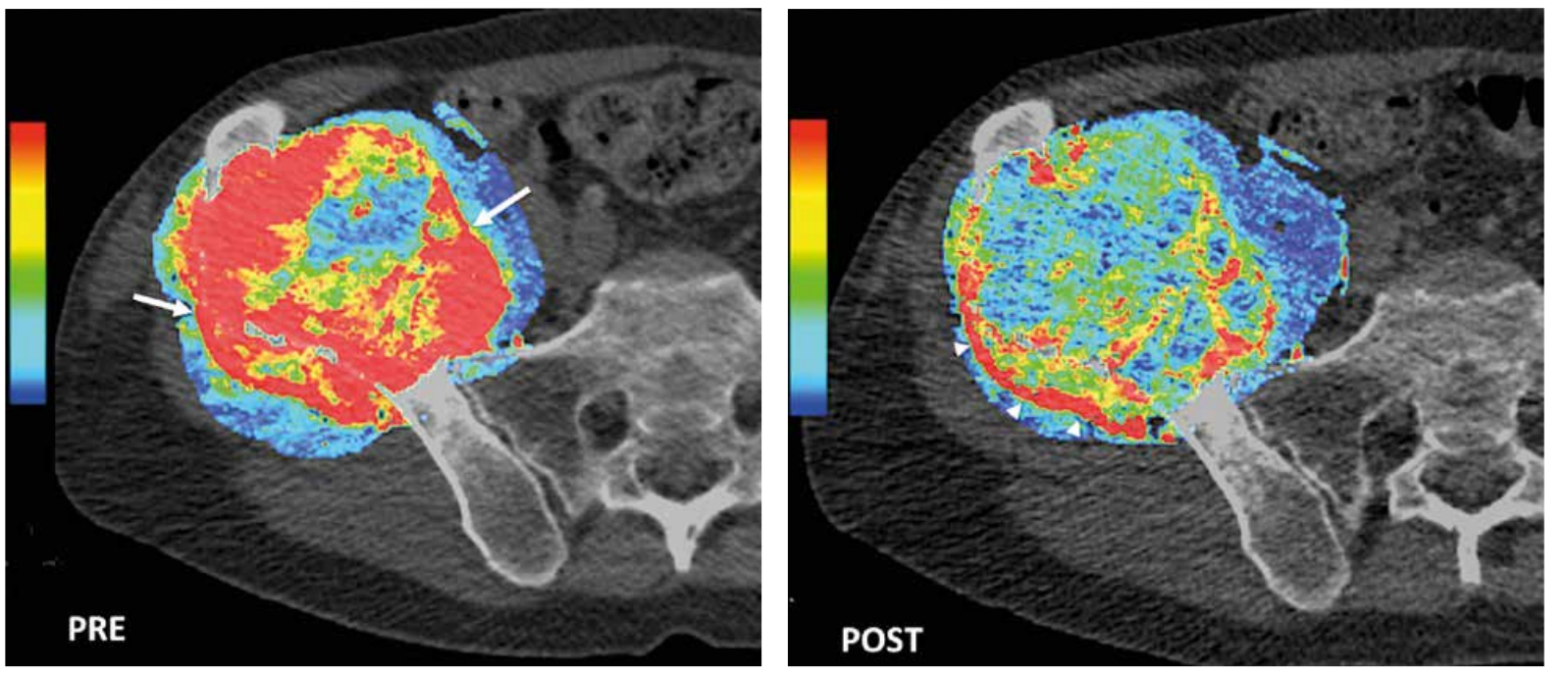
HYBRID IMAGING ONCOLOGIC

Imaging in oncology: moving from familiar paths to new terrain

Radiology needs to constantly align itself to the continually changing requirements of modern medicine. One important challenge for radiologists and medical scientists is to determine how clinical images can be used optimally to guide therapeutic decision-making. Medical imaging can now leverage quantitative techniques in order to support a wide range of clinical and research goals. Quantitative imaging refers to the deriving of measurements from medical images. If these measurements are objectively obtained and evaluated as indicators of normal biological or pathological processes, or responses to therapeutic interventions, then they can be termed 'biomarkers'.

In today's session, Prof. Horst K. Hahn from the Institute for Medical Image Computing, Bremen, Germany, will discuss, among other things, the concepts behind quantification and how to optimise the acquisition of images for quantitative imaging.

Specifically, quantitative imaging can be used to track changes induced by targeted tumour therapies, as Prof. Roberto García Figueiras, from the department of radiology, Complexo Hospitalario Universitario, Santiago de Compostela, Spain, plans to show in his presentation. According to García Figueiras, clinical imaging systems are a significant source of non-invasive imaging biomarkers that may reflect important biological properties of cancers. "They can provide quantitative information on tumour hallmarks and be used to evaluate tumour heterogeneity. Also, they may help to improve the understanding of the mechanism of action of therapies and their effects on tumour microenvironment, offering objective measures of change in response to therapy," he said.



Bone metastasis in a patient with a clear cell renal cancer. Perfusion CT blood flow (BF) colour-coded parametric map fused (50% transparency) with conventional CT obtained before (PRE) and 14 days after (POST) antiangiogenic therapy. Pre-therapy image showed a hypervascular metastasis in the right iliac bone (white arrows) with extensive areas of increased perfusion (red colour) (mean BF values = 85 mL/min/100g). Before treatment, there was a clear reduction of perfusion values within the metastatic deposit (mean BF values = 24 mL/min/100g). Functional imaging techniques are usually analysed using global statistical indexes, such as mean or median operators, that often permit measurement reproducibility, while disregarding tumour heterogeneity. In this setting, a thin peripheral rim with persistence of high perfusion values was depicted after therapy (white arrowheads).
(Provided by Prof. Roberto García Figueiras)

Heterogeneity is a common feature of tumours. "Malignant tumours are biologically complex systems with spatially variable gene expression patterns, consecutively variable biochemistry, histopathology, and macroscopically variable structure. In the tumour microenvironment, genetic variability of tumour cells meets external stressors and the host immune system, which results in a regional heterogeneity of stromal architecture, biological activity and expression of, among other things, chemokines and growth factors," said Dr. Michael Eisenblätter, from the department of clinical radiology, University Hospital Münster, Germany.

"Consecutively, the development of tumour vasculature, nutrient supply, cell growth, and death, exhibit significant regional variation, which occurs within a single tumour lesion, between a primary tumour and metastases, and of course between tumour lesions, even of the same tumour type, in different individuals," he added.

Tumour heterogeneity can be assessed by using genomic, histologic or imaging data. However, it is difficult to assess intratumoural heterogeneity with random sampling or biopsy as this does not represent the full extent of phenotypic or genetic variation within a tumour. Prof. Dr. Evis Sala, from the department of radiology, University of Cambridge, will consider the importance of quantifying the heterogeneity and genomic variability in ovarian cancer subjects.

Collectively these talks will evaluate the possible clinical benefit of imaging methods providing non-invasive ways to assess the heterogeneity within a tumour. Generally, tumours with high intratumoural heterogeneity have been shown to have poorer prognoses. At the same time, a high degree of heterogeneity is increasingly relevant for therapy selection and monitoring, due to ever more specific therapy approaches. "Various imaging approaches allow for visualisation of spatial heterogeneity in tumours. However, recorded and documented information is often limited to lesion size and macroscopic heterogeneity. In this context, relevant information, silently acquired even during clinical standard examinations, is ignored and dismissed unused," said Eisenblätter. He suggests that part of the answer lies in a rigorous analysis of all radiological imaging data: "It may help to discover this hidden information and provide additive information on tumour biology, which is highly relevant for tumour therapy."

Today's ECR Master Class, which will be chaired by Prof. James O'Connor, from the Division of Cancer Sciences, University of Manchester, will close with a panel discussion addressing the question 'What quantitative features of the tumour microenvironment can we quantify, and when is it essential?'

E³ – ECR Master Class: Hybrid, Molecular and Translational Imaging

Sunday, March 3, 08:30–10:00, Room M 1
E³ 1726a Quantitative imaging in oncology

» Chairperson's introduction
J. O'Connor; Manchester/UK

A. Intra- and intertumoural heterogeneity and the impact for cancer diagnostics
M. Eisenblätter; Münster/DE

B. Quantitative image biomarkers for targeted tumour therapies
R. García Figueiras; Santiago de Compostela/ES

C. From quantitative imaging to radiomics and deep learning
H.K. Hahn; Bremen/DE

D. Imaging heterogeneity and genomic variability in ovarian cancer
E. Sala; Cambridge/UK

» Panel discussion: What can we quantify and why is it essential?