3: Advances in cancer detection and imaging

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Session Introduction

Title: **Imaging of exogenous gene expression for personalizing therapy**

Dr. Vikas Kundra, University of Texas M.D. Anderson Cancer Center, USA

Title: **DynaCT as a new tool for onsite and realtime navigation in the lung**

Dr. Wolfgang Hohenforst-Schmidt, Klinikum Coburg GmbH, Germany

Title: **Individualized chemo-radiation therapy based on quantitative functional imaging**

Dr. Dag Rune Olsen, University of Bergen, Norway

Title: **Targeting EGFR for fluorescence optical imaging of cancer**

Dr. Haibio Gong, LI-COR Biosciences Inc., USA

Title: **Squamous cell cancer of the head and neck - preoperative TNM staging with functional computed tomography imaging**

Dr. Agnieszka Trojanowska, Medical University of Lublin, Poland

Title: **Digital imaging in mammography helping enhancing the detection & diagnosis of breast lesions**

Dr. Bhawna Dev, Sri Ramachandra University, India

Wolfgang Hohenforst-Schmidt, J Cancer Sci Ther, 3:7
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DynaCT as a new tool for onsite and realtime navigation in the lung

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DynaCT is a quite new mode of rotational fluoroscopy that provides CT like images with an angiographic system (Siemens AG Healthcare, Forchheim, Germany). This innovative imaging modality has found its way into a variety of interventional procedures. Image acquisition is achieved in approx. 8 seconds by a C-arm rotation of 220 degrees and an acquisition of 450 images. A volume set is reconstructed on workstation and is available for assessment in less than 1 minute in the interventional suite. This volume can than be further processed and overlayed on the fluoro image to guide procedures. Since the C-arm gantry is open DynaCT is well suited for hybrid interventions. Therefore established applications include cardiovascular therapy (electrophysiology, endovascular aortic repair and transcatheter aortic valve replacement), neurointerventions for cerebral aneurysms and interventional oncology.

Obtaining soft tissue information without administration of contrast medium is until now a less explored application field. We hereby describe how DynaCT could support the growing field of pneumology and its focus on diagnosing and treating early stage lung cancer. In that context our 2 DynaCT-suites themselves serve as a standard thoracical computertomography (TCT), a sophisticated fluoroscopy for all kinds of bronchological interventions and as an conjunct of 3-dimensional CT information projected into fluoroscopy images. Thereby real-time and onsite navigation without additional tools (like superdimension) are easily possible. This technique is regularly applied since autumn 2010 with very favourable results and could be part of a daily workflow for local ablation therapies in NSCLC like Intratumoral Chemotherapy or Radiofrequency Ablation.

Biography

Dr. Wolfgang Hohenforst-Schmidt works as a senior physician executive in the field of interventional pulmology including chest oncology, interventional cardiology and intensive care medicine since more than one decade. He is author of the national guideline commitee on Pulmonary Hypertension (Dtsch Med Wochenschr 2010; 135: S102-115). In interventional pulmology he published new methods like perthoracical endopulmonary ultrasound to guide peripheral cancer biopsies (49th Congress of the German Society of Pulmology (DGP) 2008, Lübeck, P79) and reported for the first time surprising survival rates in NSCLC-patients following an interventional program that used controlled submaximal physical exercise as adjunct treatment to standard therapy (Medical Tribune 2010; 31/32: S16). On the 16th World Congress of Bronchology in Budapest he presented surprising preliminary data on survival of patients treated with ITC in combination with intravenous chemotherapy (16th WCB 2010, Budapest, A-0190).

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Individualized chemo-radiation therapy based on quantitative functional imaging

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Functional imaging provides non-invasive quantitative information about biological and physiological processes of relevance for the response to treatment, and may as such be critical for the development of individualized cancer therapy. PET-imaging - with appropriate tracers - enables visualization of the tumor energy metabolism, cellular proliferation, apoptosis, angiogenesis, hypoxia as well as receptor status, whereas tracer kinetics can be quantified from 4D PET imaging. Dynamic contrast enhanced (dce) MR imaging can be utilized in deriving voxel-wise information about e.g. blood perfusion of the tumor as well as information about the extra-cellular space. Tumor hypoxia has been shown to correlate to quantitative dce-MR images. Based in diffusion weighted MR imaging, the apparent diffusion of water molecules can be measured and information about cellular integrity of tumor tissue can be derived. MR spectroscopy provides quantitative information about various metabolites in the tumor tissue.

Vast amount of information about biological features that - directly or indirectly – are of importance for the response to therapy requires advanced mathematical tools in the search for complex mechanism and relationships. Artificial neural networks (ANN) is one example of such strategies that can be utilize in computer assisted clinical decision -making. ANN analysis of various quantitative MR parameters have e.g. shown to be able to predict response to chemo-irradiation in pre-clinical tumor models.

Quantitative functional imaging provides information about tumor biological features in addition to that of genomics and proteomics, and should be integrated into a cancer systems biological approach towards individualized cancer therapy.

Biography

Dag Rune Olsen holds a Ph.D in biomedical physics, University of Oslo. He has been department head/head of research at the Institute of Cancer Research, The Norwegian Radium Hospital, Oslo, and professor of biomedical physics, University of Oslo. Professor Olsen is now Dean of Science at the University of Bergen. He has published more than 100 papers in international peer-review journals. Olsen is member of editorial boards and international advisory boards of international scientific journals as well as member of the board of the European Society of Therapeutic Radiology and Oncology. He is the recipient of the 2008 Klaas Breur Award.

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Targeting EGFR for fluorescence optical imaging of cancer

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Dysregulation of epidermal growth factor receptor (EGFR) is associated with many types of cancers. It is of great interest to noninvasively image the EGFR expression *in vivo*. Among different modalities, fluorescence optical imaging has the advantage of low cost, easiness of handling and simplicity for multiplexing. Fluorescence in the near-infrared (NIR) spectral region is especially desirable due to its reduced background and high penetration capability. Various EGFR-targeting molecules have been studied for molecular imaging. These include antibodies, antibody fragments, natural ligand EGF, nanobody and affibody. A couple of examples will be discussed, with the focus on IRDye® 800CW labeled EGF (EGF800) and EGFR-specific affibody (Eaff800).

Both EGF800 and Eaff800 were characterized for binding/uptake using EGFR-overexpressing cells. When used for *in vivo* tumor imaging, the signal intensities of EGF800 had a good correlation with tumor sizes. In an orthotopic prostate tumor model, the tumor growth was successfully tracked by EGF800. *In vivo* imaging study of Eaff800 was conducted in A431 xenograft tumors. The accumulation of EGF800 in the tumor could be identified 1 hr post-injection, and became most prominent after 1 d. The specificity of Eaff800 was confirmed by its high level of binding/uptake by A431 cells and low binding/uptake by HER2-overexpressing cells. In combination with an HER2-specific probe Haff682, Eaff800 could be used to distinguish between A431 (EGFR-overexpressing) and SKOV3 (HER2-overexpressing) tumors. Interestingly, the organ distribution pattern and clearance rate of Eaff800 were different from those of Haff682. While Haff682 accumulated predominantly in the kidney, more Eaff800 was found in the liver.

Biography

Haibiao (Herbert) Gong earned a Ph.D. degree in molecular biology at National University of Singapore. He did his postdoctoral research at University of Pittsburgh, School of Pharmacy, and joined LI-COR Biosciences as a research scientist in 2007. His research focus at LI-COR is near-infrared fluorescence imaging. He has published more than 30 papers in reputed journals.

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Squamous cell cancer of the head and neck - preoperative TNM staging with functional computed tomography imaging

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University Medical School in Lublin, Poland

Squamous cell cancer (SCC) of the head and neck , like other malignancies, should be reported with regard to TNM classification and treated accordingly. Sole anatomic imaging has its drawbacks, as early lesion detection often remains challenging, and non-neoplastic processes, especially inflammation, can mimic malignancies.

Computed tomography perfusion (CTp) is a technique that allows quick qualitative and quantitative evaluation of tissue perfusion by generating maps of blood flow (BF), blood volume (BV), and mean transit time (MTT). Perfusion CT has been found to be useful for non-invasive diagnosis of many diseases like cerebral ischemia and infarction, tumoral neo-angiogenesis, differentiation between malignant and benign process and for tumour response to radio- and chemotherapeutic treatment. Recent studies point, that CTp parameters may provide reliable information on vascularization of lymph nodes and may reflect angiogenic activity, helping to understand the changes occurring when malignant process invades the lymph node.

CTp is becoming a powerful tool in oncology and head and neck surgery. Depicting differences in tissue perfusion between different structures, shows promise in distinguishing malignant infiltration.

Biography

Agnieszka Trojanowska has completed her Ph.D at the age of 26 years from Lublin Medical University and postdoctoral studies from the same university. She has been working as senior research fellow in Radiology Department in Lublin Medical University for last 10 years. She is a specialist in head and neck radiology, and at present the head of Polish Society of Head and Neck Radiology. She has published 38 papers in reputed journals and has been serving serving as a reviewer in 4 international journals.

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Digital imaging in mammography helping enhancing the detection & diagnosis of breast lesions

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The medical imaging field has been considerably impacted in recent years by the emergence of digital imaging modalities, including **Computed Radiography** (CR) and **Digital Radiography** (DR).

The similarities between CR and DR technology are the resultant image is in the digital format, the image formats are compatible for storage in the digital Picture Archiving and Communication System (PACS) and the appearance of the digital images can be manipulated.

Digital imaging permits computer-aided detection which provides a supportive role to Radiologist during diagnosis. Computer aided detection also commonly known as **Computed Aided Diagnosis** (CAD), uses a computer program to detect features likely to be of clinical significance in images and highlights it. **Digital Breast Tomosynthesis** is a newly emerged digital mammography technique that produces a 3-dimensional image of the breast.

The high spatial resolution and wide acquisition angle results in the production of mammography images with unparalleled image quality which enables better analysis of the type and size of lesions as well as microcalcifications compared to conventional methods. **Contrast Digital Mammography (CDM)** It has been shown that the growth and metastatic potential of tumors can be directly linked to the extent of surrounding angiogenesis. This motivates the use of contrast medium uptake imaging methods to aid in the detection of cancer. The important advantages of digital imaging is an overall decrease of radiation dose to the patient, tolerance to over or under exposure, possibility to utilize post-processing techniques that can make the image diagnostically better.

Biography

Dr Bhawna completed her graduation from Guru Nanak Dev University , Amritsar and her post graduation – M.D. Radio diagnosis from Sri Ramachandra University, Chennai India in the year 2000. She is presently working as Professor of Radiology in Sri Ramchandra University Chennai, India.

She has special interest in Oncology and is expert in performing non-vascular image guided interventions like radio frequency ablation , vertebroplasty & image guided biopsies may it be vertebral, muscular ,mediastinal structures , visceral organs or breast .

She is the co- founder & resource person for Indian Academy Of CT guided interventions "IACTI". She has been conducting various CME programmes and hand on workshops for years together.

She has multiple international & national publications to her credit. She has won numerous awards and has been a constant winner for Case of The day awards in RSNA.