Ultrasound (US) is one of the most common clinical imaging modalities due to its low cost, speed, simplicity, and safety. In this modality, a transducer which emits high frequency sound waves (>20 kHz) is placed against the skin and US images are obtained based on the sound wave reflected back from the internal organs. US contrast agents can greatly improve imaging by introducing a material with different acoustic properties from that of tissues, such as gas-filled microbubbles. When a sonic energy field is applied, the gas-filled microbubbles oscillate and vibrate and may reflect ultrasound waves. The intense radial oscillation of microbubbles makes them several thousand times more reflective than normal body tissues and emits significantly stronger acoustic signal. More recently, these bubbles have been successfully used for molecular imaging by incorporating ligands on their surfaces that will adhere to cellular and other components within the microvasculature, giving it the ability to diagnose of diseases at an early stage.

Besides imaging, Ultrasound becomes more powerful while exploring its "radiation force" property, i.e. Could use ultrasound to move or manipulate objects. Targeted drug delivery is increasingly being recognized as a key limiting factor of drug efficacy. On the one hand, microbubbles are wonderful tool as gene and drug carriers. On the other hand, US mediated drug delivery may play a major role in improving the local deposition of a chemotherapeutic agent and reducing the systemic side effects. This is the case when using nanocarriers sensitive to mechanical forces and/or to small temperature elevations. The effect of US in tissue allows the local deposition of drugs from nanocarriers circulating in the blood, and/or their local activation. Extravasation and membrane permeability are also enhanced by US cavitations. All of these effects collectively improve the delivery of genes into cells and cause increased extravasation of drugs and drug carriers at the site of disease. This new field of US triggered drug delivery opens up opportunities for Pharma to expand applications for their existing small drugs in musculoskeletal disease as well as for macromolecular drugs and genes.

Brief CV

Research Area(s): Hairong Zheng is a Professor of Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences. He received his Ph.D. degree from University of Colorado at Boulder in 2006. Dr. Zheng is the director of SIAT-Institute of Biomedical and Health Engineering (IBHE), and director of Paul C. Lauterbur Research Centre for Biomedical Imaging. Dr. Zheng's research areas focus on ultrasonics, ultrasonic imaging-drug delivery-therapy, and multimodality medical imaging. Dr. Zheng has published more than 100 peer-reviewed journal papers and international conference proceedings, and owned more than 20 patents. Dr. Zheng was a recipient of the Tan Kah Kee Young Scientist Award of China (2014), and National Outstanding Young Scientist Award of China (2013), American Heart Association Pre-doctoral Fellowship (2005). Dr. Zheng is an Associate editor of IEEE Transactions on UFFC, editoral board member of Ultrasound in Medicine and Biology, editorial board member of Physics in Medicine and biology, the chairman of IEEE EMBS Shenzhen Chapter.

Technical Expertise: Ultrasound imaging techniques and ultrasound-mediated drug delivery

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X-RAY BASED ADVANCED IMAGING METHODS FOR PRIMARY AND METASTATIC CANCER

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X-ray based imaging technology is, and has remained since Roentgen's discovery of the X-ray in 1895, the single most important imaging methodology for diagnosing the cause of focal bone lesions. Simple conventional radiographs play a major role in detecting and narrowing the differential diagnosis of both lytic and sclerotic bone abnormalities including both benign and malignant tumors of bone. Computed tomography (CT), complex-motion tomography or digital tomosynthesis and fluoroscopy are additional ways of presenting the data that can be generated by X-ray technology. They allow more detailed analysis of anatomy and of the structural components of lesions. Hybrid CT (PET/CT and SPECT/CT) can be used to stage patients and evaluate their response to treatment by coupling the anatomic information available in the CT with the physiologic information available in PET or in nuclear medicine bone scanning. We will present a variety of cases to illustrate how these imaging modalities contribute to the diagnosis and staging of common and unusual bone tumors. Details regarding imaging parameter selection, when critical, will be explained. Advanced methods will be explored and compared. For example, metal artifact reduction capability in CT will be demonstrated using case materials. The potential of multi-spectral CT for quantitating bone density will be addressed.

Brief CV

Research Area(s): CT, radiation dose, cancer imaging

Technical Expertise: CT Technology

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MUSCULOSKELETAL IMAGING APPLICATIONS WITH PET/MRI

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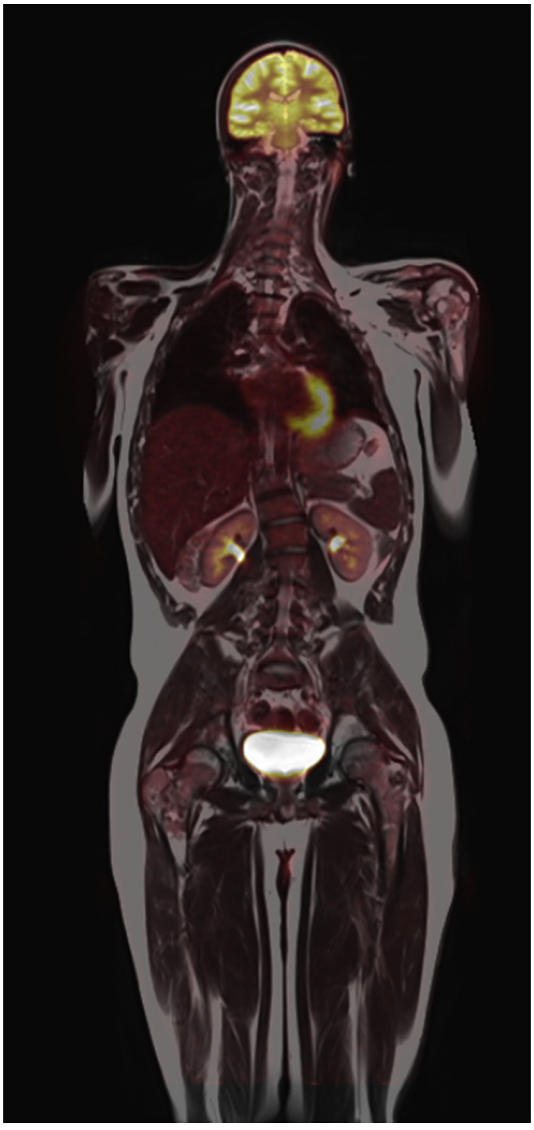
PET/CT imaging using FDG has become a corner stone in oncologic imaging, with wide latitude of additional applications in assessing neurological, musculoskeletal and cardiovascular pathology. PET/MRI imaging represents an evolution of PET technology, and offers the fusion of two highly advanced imaging technologies that combines the highly sensitive functional aspects of PET imaging fused with the exquisite soft tissue information offered by high resolution MR imaging.

While there is already a promise for using FDG PET/MRI in the WB oncologic setting, PET/MRI for assessment of musculoskeletal (MSK) diseases is in its infancy. While PET/CT provides robust bone anatomic detail and has yielded good results for bone pathology, fusing PET with MRI will help image pathologic processes at the cellular level that often precedes anatomic alterations.

After introducing the concept of functional imaging, this talk will discuss the rational of PET/MRI, followed by discussion of the common challenges with respect to systems constructs, attenuation correction, and workflow that had to be addressed. The advantages and disadvantages of simultaneous versus sequential acquisition PET/MRI scanning will be shown, specifically in

references to motion correction, quantification, and registration artifacts. Various PET/MRI protocols, with particular attention to MSK pathology and the use of advanced MR techniques (e.g. WB DWI and WB STIR) will be discussed. Various case examples, including its potential benefit in the initial assessment of multiple myeloma, bone and soft tissue tumors, its value in restaging in MSK tumors, and its potential role in therapy response assessment will be introduced. While FDG is the most common radionuclide used today, the possibility of using this architecture in the era of personalized medicine, with development of targeted tracers and receptor-specific tagged antibodies linked to various radionuclides will be explored.



Whole body PET/MRI FDG image demonstrated successfully treated bone lymphoma.

Brief CV
Research Area(s): BMD/osteoporosis/orthopedic applications, MRI sequences, Informatics, MSK imaging
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MULTIMODAL IMAGING OF EXPERIMENTAL BONE METASTASIS

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Bone is among the most common locations of metastasis and therefore represents an important target for diagnostic imaging in cancer patients as well as in preclinical research. Non-invasive imaging modalities monitor molecular, functional and morphologic changes in both compartments of these skeletal lesions — the bone and the soft tissue tumor compartment. In the bone compartment, morphologic information on skeletal destruction is assessed by computed tomography (CT) and radiography. Pathogenic processes of osteoclast and osteoblast activity, however, can be imaged using optical imaging, positron emission tomography (PET), single photon emission CT (SPECT) and skeletal scintigraphy. Accordingly, conventional magnetic resonance imaging (MRI), ultrasound and CT as well as diffusion-weighted MRI and optical imaging are used to assess morphologic aspects on the macroscopic and cellular level of the soft tissue tumor compartment. Imaging methods such as PET, dynamic contrast-enhanced techniques and vessel size imaging further elucidate on pathogenic processes in this compartment including information on metabolism and vascularization. By monitoring these aspects in bone lesions, new insights in the pathogenesis of skeletal metastases can be gained when complementary information from multimodal imaging is combined. This talk summarizes emerging and established imaging techniques in experimental bone metastasis for the assessment of tumor and bone cell activity including molecular, functional and morphological aspects. Finally, the translation of multimodal imaging techniques of skeletal lesions into the clinical situation is demonstrated for cancer patients.

Brief CV
Research Area: Clinical and experimental imaging of malignant bone lesions using different modalities
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VIRTUAL REALITY BASED SURGICAL SIMULATION

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The main focus of surgical simulation is to develop and deliver virtual reality based training and computer enhanced learning in surgery. Traditionally, medical students learn diagnostic, therapeutic and surgical skills through difficult clinical training on patients. Advanced technologies such as virtual reality and visualization can help to make the surgical training process more efficient, engaging and flexible. It is possible to construct immersive virtual environments to provide realistic visualization and dexterous haptic feedbacks for surgical training. In this talk, I would introduce related virtual