What Life Scientists Should Know About Molecular Imaging

Optical Imaging, Ultrasound, Photoacoustics

Physics of Ultrasound Imaging – Contrast Agents and Flow Imaging

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Learning Objectives:

- Gain basic understanding of ultrasound B-mode and Doppler imaging
- Understand the physical properties of microbubble contrast agents
- Learn about contrast agent detection and quantification techniques and preclinical protocols
- Get an understanding of new development trends in ultrasonic imaging

Owing to the very sensitive detection of microbubble contrast media, ultrasonic imaging has become a modality for molecular imaging. With the availability of high-frequency small animal ultrasound scanners, B-mode and contrast imaging have become important research tools. The main focus of this year's session is on ultrasound contrast media, which are micrometer-sized gas-filled bubbles that are stabilized by a soft shell (e.g. phospholipids) or a hard shell (e.g. polymers). They show characteristic behavior like non-linear scattering of ultrasound and at higher intensities also destruction in the sound fields of diagnostic ultrasound scanners. These properties can be utilized for their sensitive detection and quantification. The talk first gives a short introduction to the underlying physical principles of ultrasound imaging used in clinical scanners and laboratory small animal scanners. Then the physical properties of microbubble contrast agents like resonance, non-linear scattering, and fragmentation or cracking are presented. Based on this, different methods for their sensitive detection and scanning protocols for quantification that are used in current preclinical studies are discussed. Ultrasound contrast agents are also used for the measurement of flow by Doppler-imaging or related techniques. Therefore, a short summary of ultrasound flow measurement techniques will be given. Application examples for anatomical and molecular imaging with microbubble contrast media will be presented and discussed.

Relevant Publications:

1. Ferrara, K., Pollard, P., Borden M.: Ultrasound Microbubble Contrast Agents: Fundamentals and Application to Gene and Drug Delivery. Annual Review of Biomedical Engineering. Vol. 9: 415-447
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5. Postema M., Schmitz G. Bubble dynamics involved in ultrasonic imaging. Expert Reviews of Molecular Diagnostics. 2006;6(3):493-502.

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Disclosure of author financial interest or relationships: G. Schmitz, None.