In vivo X-Ray Phase Imaging

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In this issue of *EBioMedicine*, the article by Velroyen et al. (2015) is a most recent presentation of the evolving x-ray imaging technology that is based on use of x-ray photons that deviate from the straight line described by the “ballistic” photons due to changes of the phase of the wave front that the x-rays undergo when passing through tissue. “Ballistic” photons are assumed to follow a straight path linking the x-ray source and detector pixel and form the basis of the attenuation based shadow graph imaging method that is used in essentially all routine x-ray imaging methods since its initial development by Roentgen and subsequent application to medical computed tomographic imaging by Hounsfield. This article by Velroyen et al. involves the measurement of the miniscule deviation of x-ray photons from the “ballistic” path caused by the refraction of the x-ray by tissue (Velroyen et al., 2015). Their study used microscopic venetian blind-like metal grids that predictably diffract the x-ray photons so that any deviation from that known diffraction deviation can be quantitatively related to the cumulative refraction as the x-ray photons pass through tissue.

The Velroyen scans did not use “gated” scans, i.e., piecewise accumulation of the necessary multi-angular scan data synchronized with a biological signal such as a selected phase of the respiratory cycle. Gating of CT scan acquisition is not novel in micro-CT (Badea et al., 2004), but because of the need for very high spatial precision and reproducibility of the image data acquisition at each angle of view, its demonstration of its feasibility in a living mouse would be a considerable contribution. Without gating and 5-second duration exposures at each angle of view, the role of image blurring is not clear. The study highlights that structural information at a scale smaller than the detector pixel size can be obtained. The detection of sub-pixel structural information is particularly important for several reasons. In conventional shadow-graph x-ray imaging a sub-pixel structure cannot be unambiguously quantified (Verchacke et al., 2014). The importance of this issue is well demonstrated by the desire to quantify structural aspects of lung alveoli. These alveoli consist of little spherical air sacks 100–250 μm in diameter and enclosed by a spherical shell consisting of a layer of cells a few micrometer thick (Bachofen et al., 1987). Alveolar wall thickness, as well as alveolar air space’s peripheral limb would be a very good start) to address questions such as (i) what is the role of x-ray photon energy and
spectral bandwidth?, (ii) what is the impact of tissue heterogeneity on the number of different phase shifts along the x-ray photon path?

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