

From Basic Synchrotron Research to First Clinical Applications: X-ray Darkfield Imaging for Lung Diseases

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This contribution will review our efforts, key achievements, and pitfalls during our ten-year journey to translate grating-based X-ray darkfield imaging from the optical bench to clinical bedside.

Early Years of Grating-Based Imaging: Grating-based phase- and darkfield-contrast X-ray imaging has been translated from synchrotron sources to laboratory benches about a decade ago [1-3]. This milestone has increased the interest in grating-based phase- and darkfield-contrast in the medical community, as it provided a perspective to implement phase-contrast and darkfield imaging also with conventional X-ray generators, which are compatible with presently used medical X-ray systems in radiology.

Small-Animal Trials: After the initial development years of the basic technology and image processing aspects of grating-based imaging, we have then focused on developing a first small-animal darkfield imaging platform [4]. After the first successful in-vivo images [5], this device has been used to carry out several studies on small-animal lung disease models. The results of these studies have clearly demonstrated that darkfield radiography can improve the detection of chronic obstructive pulmonary disease (COPD) [6,7], lung fibrosis [8], lung cancer, pneumothorax, pneumonia, or damage due to mechanical ventilation.

Translation to clinical requirements: Based in these small-animal results, we then continued to develop the technology further to high energies and large fields-of-view to be compatible with the technical requirements of typical clinical chest X-ray applications. These efforts have led to successful demonstration experiments in in-vivo large-animal models [9] and human cadavers [10], and allowed us to subsequently refine the technology, image processing and dose requirements such that a first clinical prototype was finally in reach. The latter has been constructed during the last three years at the TUM Klinikum rechts der Isar, and finally cleared for patients end of 2019. During this process we have addressed all regulatory issues, i.e. approval according to the German medical device regulations, approval by the national ethics board, and approval by the German radiation safety authorities.

Results from first patient study: Presently we are conducting a first patient study to demonstrate the potential of darkfield chest radiography to improve detection and precise diagnosis of lung diseases, with a particular focus on chronic obstructive pulmonary disease (COPD). In this presentation, we will review the most important findings of approx. hundred patients.

References :

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