

INDIVIDUAL PARTICULATE MUCOCILIARY TRANSIT ANALYSIS USING SYNCHROTRON X-RAY IMAGING



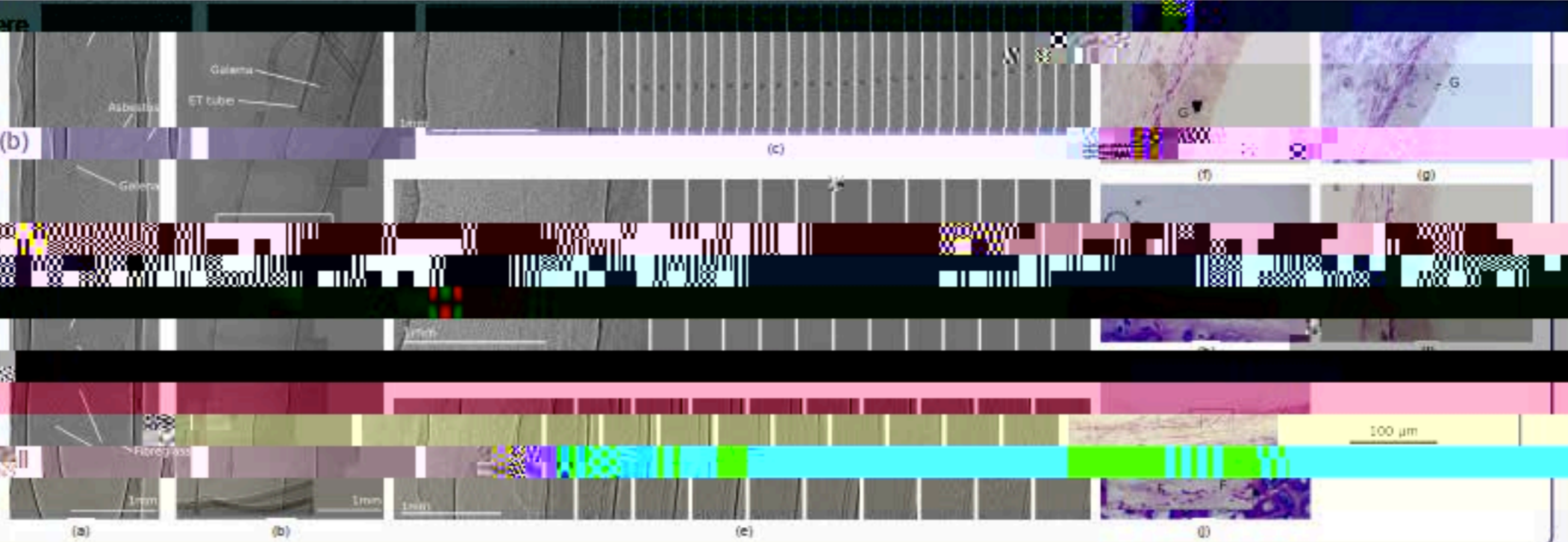
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BACKGROUND: The ability of the airways to move and clear deposited particles is a clear diagnostic indicator of airway health. Prior to the development of synchrotron phase contrast X-ray imaging (PCXI) non-invasive detection and tracking of individual particle movements produced by mucociliary transit was not possible. Since MCT is affected in cystic fibrosis, the ability to quantify MCT in CF disease models could assist in examining airway surface and responses to treatment. Using PCXI we have begun to dynamically and non-invasively examine the behaviour of individual pollutant particles deposited on the airway surfaces of live intact mice to document particle visibility and behaviour.

MATERIALS AND METHODS: Experiments were performed on the BL20XU beamline at the SPring-8 synchrotron. Asbestos, fibreglass, quartz dust, galena lead ore, and reference hollow silver-coated glass beads were examined. One HOS:HR-1 mouse was humanely killed, the trachea excised, and particulate delivery was tested *ex-vivo*. *In-vivo* was then examined in anaesthetised mice. Doses of 1% w/v particulates in saline were delivered to the trachea via an oral ET tube. Post-experiment the mice were humanely killed and the trachea was excised, fixed in PFA, and examined with light microscopy.

RESULTS: All particles were visible *ex-vivo*, but asbestos was not visible in *in-vivo* experiments. (a) *Ex-vivo* results showing the appearance of particulates. (b) The ET tube and imaging region. (c) Galena clump swirling *in-vivo*. (d) Particle moved up the MCT. (e) Hollow glass beads in the dorsal trachea. (f) Galena particles (f) in the epithelium and (g) trapped in surface mucus. (h) Distinctive glass beads (h) on the airway surface and (i) displaced into the airway epithelium. (j) Silica fibreglass fibres embedded in the overlying mucus.



DISCUSSION AND CONCLUSION: Particle behaviour was related to both the type and size of the particles. Smaller particles were captured on the airway surface or in mucus. The transport of air particles was towards the dorsal tracheal wall. Histological analysis showed that galena particles and other particles displaced cilia and surface liquid to lodge into the airway. The ability to non-invasively detect and track individual particles using PCXI techniques are now a valuable addition to the suite of imaging tools available for use in live airway models.

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