DRY DEPOSITION OF POLLUTANT AND MARKER PARTICLES ONTO LIVE MOUSE AIRWAY SURFACES REVEALS HETEROGENEOUS MUCOCILIARY TRANSIT BEHAVIOUR

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BACKGROUND:

•Airborne pollutants are a considerable health concern and have the potential to impact on respiratory diseases such as cystic fibrosis (CF)

•We have previously described synchrotron imaging techniques for examining the mucociliary transit (MCT) behavior of particulates in the nasal airways and trachea of anaesthetised mice

•Our previous studies delivered particulates in a fluid bolus, however the presence of the carrier fluid perturbed the airway surface and ... the manner of deposition ... post-deposition MCT behaviour that we sought to measure

•The aim of this study was to verify that synchrotron phase contrast X-ray imaging (PCXI) can be used to detect, monitor and compare the deposition and MCT behaviour of pollutant and marker particles after dry deposition into the trachea of live mice

METHODS:

•Intubated (flexiVent ventilation) C57Bl/6 mice (n=8) were imaged on the BL20XU beamline at the SPring-8 synchrotron in Japan

•Particles ... fibreglass, quarry dust and lead ore, as well as reference 14 µm hollow gla...

pump (PennCentury, Wyndmoor, PA, USA)

... at a rate of one per breath (in an end-inspiratory pause) for five minutes using a high-resolution camera

•Images were enhanced post experiment (Matlab, The Mathworks, MA, USA), assembled into movies sh... X-ray velocimetry (XV)

RESULTS:

•The first movement of particulates tended to appear approximately 2-3 minutes after delivery

•As in previous studies the particle transit was heterogeneous: after deposition some particles did not move, while others transited the field of view rapidly

•The big and heavy particles lead and tantalum moved substantially less than the other particulates

•Most particles did not follow a linear path along ... many followed seemingly random ... paths

•There was more movement of particles along the bottom quarter of the tracheal surface than the remainder of the trachea, possibly due to the quantity of ... present and gravitational effects

•In some ... contraction of the tracheal airway throughout the imaging period

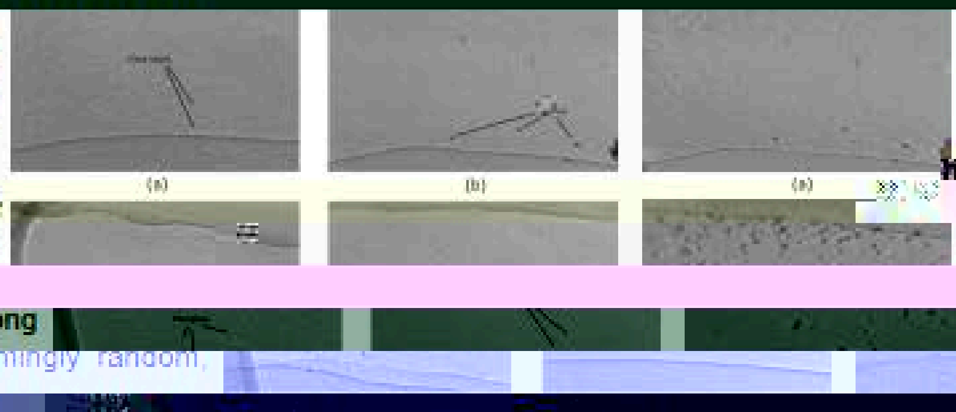

FIG 1: Particle visibility on the airway surface of four mice (a) silver coated hollow glass beads, (b) lead, (c) fibreglass fibres, and (d) quarry dust. In these static images it is hard to clearly identify some of the particles (excluding the large lead particles and fibreglass fibres), ... the imaging location is just above the main carina.

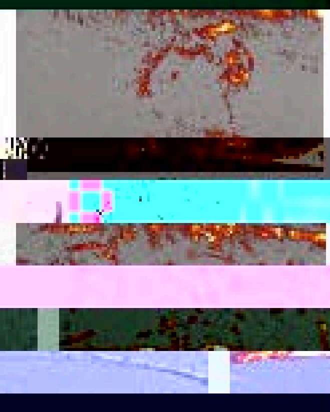

FIG 2: ... images from two animals (a) and (c) were analysed ... the sites of all lead particles ... and (d) on the airway surface over the 5 minute imaging period. The yellow and white regions contained the most particle movement. Movement in the top third of the frame ...

... X-ray velocimetry (XV) ... Engineering flow measurement technique ... movement (b) ... average, there is more particle MCT ... beads along and towards the dorsal ... of the trachea surface. A grid of the ... movement vectors ... Figure orientation and location is the sa...

CONCLUSION:

Synchrotron PCXI permits detection of particle transit via MCT along live mouse trachea. We are continuing with studies to improve our direct and non-invasive MCT assessment methods to assist our understanding and treatment of respiratory diseases such as CF.

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