MONITORING INDIVIDUAL POLLUTANT PARTICLE BEHAVIOUR ON INTACT LIVE AIRWAYS USING SYNCHROTRON X-RAY IMAGING

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Background

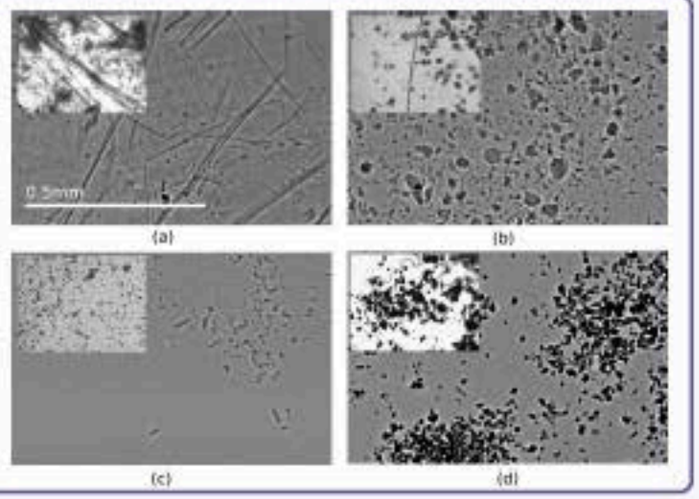
Non-biological particles small enough to be suspended in the air are continually inhaled as we breathe, and deposit on airway surfaces where they can remain and affect lung health. Pollutant particles from vehicles, building processes and mineral and industrial dusts have the potential to cause immediate and delayed health problems. Due to their small size, it has not been possible to non-invasively examine how individual particles deposit on live airways, or to consider how they behave on the airway surface after deposition. Using live intact mouse airways we have begun to examine particle behavior after deposition on the airway wall, dynamically and non-invasively, using synchrotron phase contrast X-ray imaging (PCXI).

Materials and Methods

Experiments were performed on the BL20XU beamline at the SPring-8 synchrotron in Japan. Using PCXI, the *in-vitro* detectability of a range of potentially-respirable particulates was determined. Asbestos, fibreglass, quarry dust, lead sulphate in galena, combusted diesel, PM10 and laser printer toner were tested. Detectable particulates were then delivered into the nasal airways of live, anaesthetised hairless mice (Crlj:CD1-*Foxn1-nu*). Mice were secured head-high on an imaging board, and the X-ray beam (dimensions 10 x 6mm) was directed ventro-dorsally through the mouse to image the nasal airways (where the ciliated epithelium is used as a model for the conducting airways of the human lung).

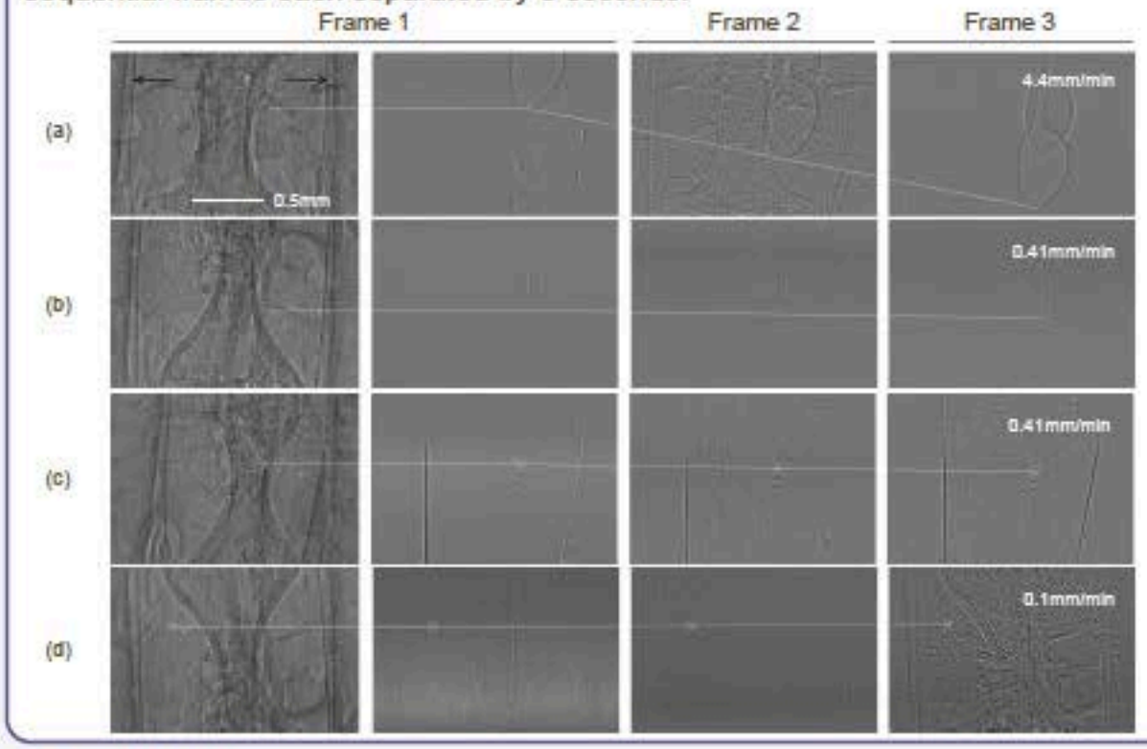
In-vitro Results

In-vitro dry particulate samples under PCXI (main pictures) and light microscope (insets): (a) asbestos, (b) quarry dust, (c) fibreglass, and (d) galena. The morphology of each of the particulates is clearly very different. The largely carbon-based particulates — combusted diesel, PM10 and laser printer toner — were not sufficiently visible to warrant *in-vivo* testing.



In-vivo Results

The two panes on the left show the original PCXI image and its corresponding motion-detected frame that revealed the moving object on the airway. The panes on the right are the next two motion-detected frames in the sequence. Black arrows mark the nasal airway edge, and white lines follow the same object across the three sequential frames each separated by 5 seconds.



Conclusion

Synchrotron PCXI provides the unique ability to detect and track deposition of individual particulates, non-invasively, in live airways. With further refinement of particulate sizing and delivery techniques PCXI should provide a novel approach for monitoring the behaviour of particulates relevant to lung health on airway surfaces.

Acknowledgements

NH&MRC, USA CF Foundation and philanthropic donors (www.Cure4CF.org). Paul Whiffen, Environment Manager, Boral Resources (SA) Limited, provided dolomite quarry dust samples. Dr Ian Gilmour, USA EPA supplied combusted diesel and PM10.