Team gets the beat, develops method of quantifying ciliary movement

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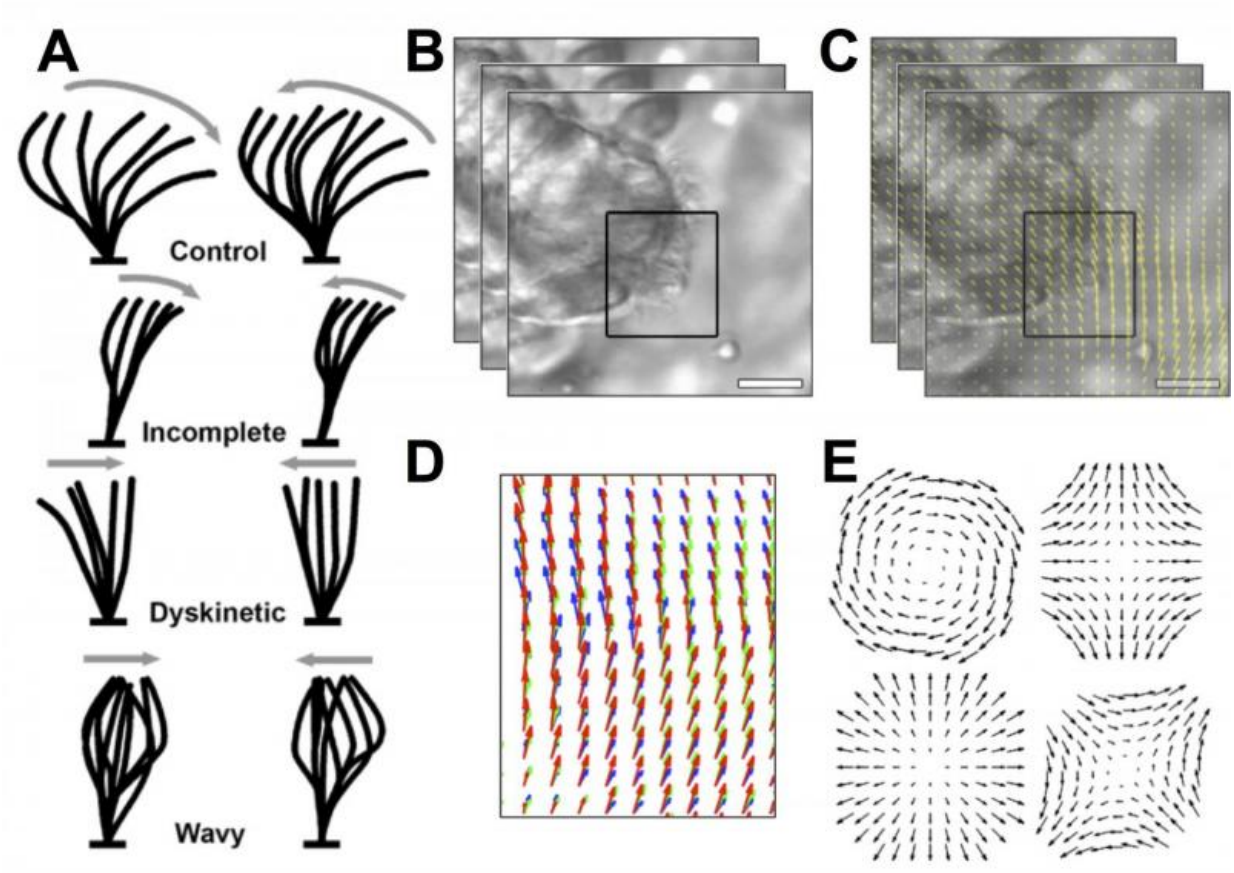

Properties of ciliary motion (CM). (A) Schematic diagrams of CM subtypes to aid clinical diagnosis. (B) Stacked frames indicate still frames of the video of the CM biopsy, and the black box indicates the region of interest selected by the clinician. (C) Yellow arrows on the images from (B) indicate direction and magnitude of optical flow for a small region of the video for each pair of frames. (D) Changes in the optical flow are used to compute the elemental components. (Red arrows, optical flow at frame t; green arrows, optical flow at frame t + 1;

blue arrows, optical flow at frame t + 2.) (E) Elemental components of rotation (top left), deformation (top right, bottom right), and divergence (bottom left; excluded from analysis), shown in a template form. Credit: Quinn et al., Science Translational Medicine (2015)

Researchers at the University of Pittsburgh School of Medicine have figured out how to objectively quantify the beating action of cilia, the tiny, hair-like projections on cells that line nasal passages, the lungs and almost every other body tissue, according to a study published online today in *Science Translational Medicine*. Such digital signatures could help doctors more quickly and accurately diagnose ciliary motion (CM) defects, which can cause severe respiratory airway clearance defects and also developmental defects including congenital heart disease.

Currently, doctors try to identify CM defects using video-microscopy or indirectly via the examination of cilia ultrastructural defects using electron microscopy. This usually entails analysis of cilia movement in respiratory cells obtained from nasal passages, explained senior investigator Chakra Chennubhotla, Ph.D., assistant professor of computational and systems biology, Pitt School of Medicine.

"Visual reviews like these can be subjective, time-consuming and error-prone," he said. "In this project, our team used computational methods to objectively and reliably identify CM defects."

The researchers used two independent data sets - one from Children's Hospital of Pittsburgh of UPMC (CHP) and the other from Children's National Medical Center (CNMC) in Washington, D.C. - from healthy individuals as well as patients already diagnosed with either congenital heart disease or primary ciliary dyskinesia (PCD) to identify the digital signatures of normal and abnormal movement, accounting for factors

such as how frequently the cilia beat back and forth, the breadth and rotation of their beat pattern, and their synchronicity.

The researchers then validated their technique by testing the patient samples in blind fashion, finding that the computational tool correctly identified more than 90 percent of PCD cases at CHP and all of the cases at CNMC. PCD is a rare condition in which the cilia are immotile or beat abnormally, leading to limitation of airway mucus clearance, compromised respiratory function and increased risk for lung infections and other bronchial problems.

"We hope to start a clinical trial in which doctors from around the country can upload a video of their patient's nasal lining to a website for assessment of ciliary motion with this technique," said co-investigator Cecilia Lo, Ph.D., Dr. F. Sargent Cheever Professor and chair of Developmental Biology, Pitt School of Medicine. "If successful, this approach may in the future serve as a rapid first-tier screen to identify at-risk patients."

More information: Automated identification of abnormal respiratory ciliary motion in nasal biopsies stm.sciencemag.org/lookup/doi/ … scitranslmed.aaa1233

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