Medical Xpress

Good Vibrations: Treating brain disease with some good vibes (w/ Video)

July 13 2010

Columbia University bioengineer Elisa Konofagou is making waves when it comes to researching treatments for degenerative brain disorders such as Alzheimer's and Parkinson's. These aren't just any waves; they're ultrasound waves.

"Ultrasound denotes acoustic wave propagation. If you increase the intensity and pressure of these waves, you can cause biological effects on tissues," says Konofagou.

With support from the National Science Foundation (NSF), Konofagou is experimenting with ultrasound technology and how it could become part of a comprehensive treatment for various degenerative brain diseases.

She's looking into using the technology as a non-invasive way to unlock one of the brain's top defense mechanisms in mammals--the blood-brain barrier that protects the brain from poisonous molecules. "The blood-brain barrier is a specialized structure that lines the capillaries of the brain, and it offers additional defense to the brain," explains Konofagou.

However, this natural protection against toxins also has a downside. Even medicines have a tough time crossing the barrier. Konofagou believes that ultrasound technology could change that. "There are 7000 pharmacological agents developed and 95 percent cannot penetrate the blood-brain barrier unless the barrier is manipulated," she says.

At her lab in Columbia-Presbyterian Hospital, Konofagou is able to open the blood-brain barrier and have it close back in mice on a regular basis.

Konofagou places a mouse a few inches under a transducer roughly the shape of an upside down teacup. It emits ultrasound waves. At the same time, she injects the mouse with a liquid solution full of microscopic bubbles. She then directs the ultrasound beam toward the brain in an area that would hit the center region of the brain on the order of less than a centimeter in diameter. "We affect a specific localized region in the brain because most brain diseases, at least at their early stages, are very localized," she explains.

Once inside the bloodstream, the injected microscopic bubbles circulate together with the needed medication. The bubbles hit the area on which the ultrasound beam is focused, and they "are set into vibration," says Konofagou.

These vibrating micro-bubbles loosen the tightly joined cells that make up the blood-brain barrier, allowing the drug to pass through. The medications can then reach their target--the neurons near the capillaries of the brain. Konofagou says that the barrier closes up within the first 24 hours and the procedure has no harmful effect on the mice when applied at low pressures.

Konofagou envisions the day when this treatment might be routinely available to humans. "The way we envision the course of treatment in humans would be similar to chemotherapy," she says. Patients would get an intravenous (IV) infusion of the liquid solution that contains the micro-bubbles in addition to medication. The individuals would then sit under a device that might resemble a hair dryer in a hair salon, but instead of emitting air, the device would emit ultrasound waves.

"One of the main hurdles is to demonstrate that it's safe, that there's no collateral damage when we open the blood-brain barrier, and that this is a reversible phenomenon," explains Konofagou. "The other issue is to make sure we can actually penetrate the skull in humans the same way we can in smaller animals."

Ultrasound treatment for diseases like Parkinson's and Alzheimer's in humans may be years off, but so far, the vibe coming from this lab is right on.

Provided by National Science Foundation