These Tiny, Medical Robots Could One Day travel Through Your Body

2023-05-29

A team of engineers at the CU Boulder has designed a new class of tiny, self-propelled robots that can zip through liquid at incredible speeds—and may one day even deliver prescription drugs to hard-to-reach places inside the human body.

The researchers describe their mini healthcare providers in a paper published last month in the journal Small.

“Imagine if microrobots could perform certain tasks in the body, such as non-invasive surgeries,” said Jin Lee, lead author of the study and a postdoctoral researcher in the Department of Chemical and Biological Engineering. “Instead of cutting into the patient, we can simply introduce the robots to the body through a pill or an injection, and they would perform the procedure themselves.”

Lee and his colleagues aren’t there yet, but the new research is big step forward for tiny robots.

The group’s microrobots are really small. Each one measures only 20 micrometers wide, several times smaller than the width of a human hair. They’re also really fast, capable of traveling at speeds of about 3 millimeters per second, or roughly 9,000 times their own length per minute. That’s many times faster than a cheetah in relative terms.

They have a lot of potential, too. In the new study, the group deployed fleets of these machines to transport doses of dexamethasone, a common steroid medication, to the bladders of lab mice. The results suggest that microrobots may be a useful tool for treating bladder diseases and other illnesses in people.

“Microscale robots have garnered a lot of excitement in scientific circles, but what makes them interesting to us is that we can design them to perform useful tasks in the body,” said C. Wyatt Shields, a co-author of the new study and assistant professor of chemical and biological engineering.

Fantastic Voyage

If that sounds like something ripped from science fiction, that’s because it is. In the classic film Fantastic Voyage, a group of adventurers travels via a shrunken-down submarine into the body of a man in a coma.

“The movie was released in 1966. Today, we are living in an era of micrometer- and nanometer-scale robots,” Lee said.

He imagines that, just like in the movie, microrobots could swirl through a person’s blood stream, seeking out targeted areas to treat for various ailments.

The team makes its microrobots out of materials called biocompatible polymers using a technology similar to 3D printing. The machines look a bit like small rockets and come complete with three tiny fins. They also include a little something extra: Each of the robots carries a small bubble of trapped air, similar to what happens when you dunk a glass upside-down in water. If you expose the machines to an acoustic field, like the kind used in ultrasound, the bubbles will begin to vibrate wildly, pushing water away and shooting the robots forward.

Other CU Boulder co-authors of the new study include Nick Bottenus, assistant professor of mechanical engineering; Ankur Gupta, assistant professor of chemical and biological engineering; and engineering graduate students Ritu Raj, Cooper Thome, Nicole Day and Payton Martinez.

To take their microrobots for a test drive, the researchers set their sights on a common

problem for humans: bladder disease.

Bringing relief

Interstitial cystitis, also known as painful bladder syndrome, affects millions of Americans and, as its name suggests, can cause severe pelvic pain. Treating the disease can be equally uncomfortable. Often, patients have to come into a clinic several times over a period of weeks where a doctor injects a harsh solution of dexamethasone into the bladder through a catheter.

Lee believes that microrobots may be able to provide some relief.

In laboratory experiments, the researchers fabricated schools of microrobots encapsulating high concentrations of dexamethasone. They then introduced thousands of those bots into the bladders of lab mice. The result was a real-life Fantastic Voyage: The microrobots dispersed through the organs before sticking onto the bladder walls, which would likely make them difficult to pee out.

Once there, the machines slowly released their dexamethasone over the course of about two days. Such a steady flow of medicine could allow patients to receive more drugs over a longer span of time, Lee said, improving outcomes for patients.

He added that the team has a lot of work to do before microrobots can travel through real human bodies. For a start, the group wants to make the machines fully biodegradable so that they would eventually dissolve in the body.

“If we can make these particles work in the bladder,” Lee said, “then we can achieve a more sustained drug release, and maybe patients wouldn’t have to come into the clinic as often.”

Read the original article on University of Colorado Boulder.