A new micro-robot delivers drugs in capsules

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An international team of researchers, led by Professor Hongsoo Choi, Director of DGIST-ETH Microrobot Research Center, has developed capsule-type microrobots that can encapsulate cells and drugs and deliver them to targeted parts of the human body. Unlike conventional methods that install cells or drugs outside of micro robots, the lids of these microrobots can be open and closed.

Professor Choi has suggested capsule-type microrobots by utilizing a capsule structure that can encapsulate cells and drugs and a propulsion system that mimics bacteria through a joint research with Professor Cheil Moon's research team from the Department of Brain and Cognitive Sciences and Professor Bradley J. Nelson's research team from the Eidgenössische Technische Hochschule (ETH) Zürich, Switzerland (Swiss Federal Institute of Technology Zurich).

The development of new technologies in the healthcare market and medical devices has been accelerating worldwide, and research in high-tech medical robotics fields such as microrobots that can deliver drugs or cells to desired areas of the body is actively underway.

Until now, most microrobots for cell and drug delivery have been mounted on the outer surface of the robots in various ways; have been fabricated into a mixture of biodegradable materials of cells or drugs that were released as the biodegradable materials were dismantled; have been developed in the form of magnetic particles for cell and drug delivery. The limitations of these types of robots are that cells and drugs can be lost by external environments when the robots are operated inside

the human body.

To overcome these limitations, the researchers developed capsule-type microrobots by combining a cap-type structure that enables opening and closing in the head of microrobots and encapsulating cells or drugs and a propulsion system that mimics the movement of the tail of bacteria.

Out of technologies for Micro Electro Mechanical Systems (MEMS), the research team developed a three-dimensional polymer structure using a three-dimensional laser lithography system. In addition, nickel (Ni), which is a magnetic material, and titanium (Ti), which is a bio-compatible material, were deposited on the surface of the capsule-type microrobots so they could be operated by an external magnetic field.

In an experiment involving capsule-type microrobots using magnetic fields, particles measuring tens of micrometers (㎛, one-millionth of a meter) were transferred using a 'pick and drop motion.' In addition, bio-compatibility experiments, which delivered live cells to the correct location by encapsulating real olfactory receptor neurons (ORN), have been successfully completed.

The capsule-type microrobots developed by the research team can contain cells or drugs and release them at any target location by using the vortex of fluid; thus, they can minimize the loss of cells or drugs in the external environment thereby delivering correct volumes. It is expected that this finding can be used to treat diseases such as degeneration of the retina by being able to maneuver in low-flow fluids in the human body such as the eyes and the brain.

Professor Choi said, "With the use of capsule-type microrobots, cells and drugs can be encapsulated and released at desired locations, so loss and denaturation of cells and drugs due to the external environment can be prevented. We will conduct further research to provide various

medical applications in the future."

Meanwhile, this research outcome was published as the cover story in the May 9 issue of Advanced Health Care Materials, an international journal in the field of biomaterials; the research was conducted with support from the Korean Ministry of Science and ICT and the Korean Ministry of Trade, Industry, and Energy.

More information: Seungmin Lee et al. A Capsule-Type Microrobot with Pick-and-Drop Motion for Targeted Drug and Cell Delivery, *Advanced Healthcare Materials* (2018). DOI: 10.1002/adhm.201700985

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