Overcoming cardiovascular disease with a magnetically-steerable guidewire microrobot

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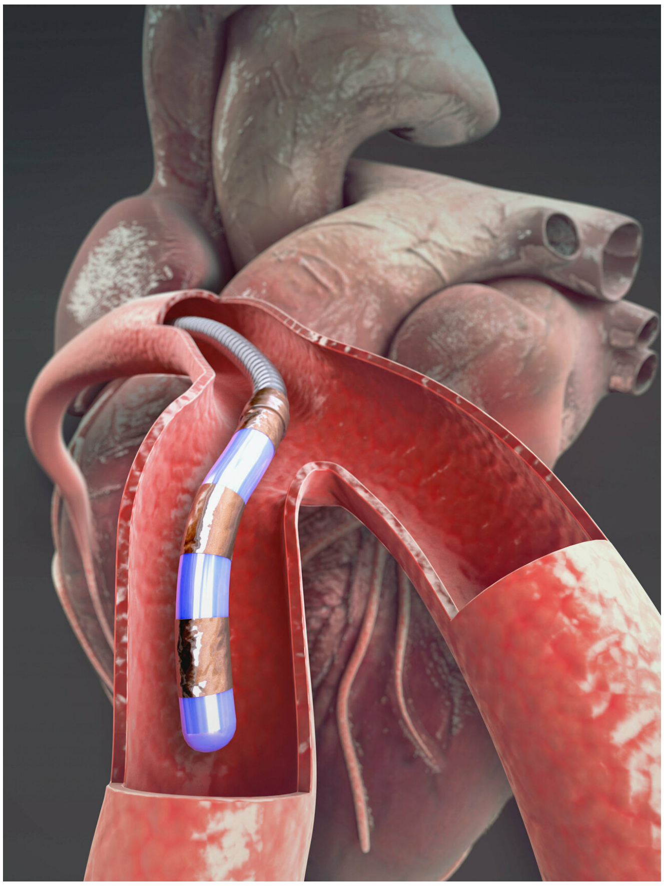


Concept map of attachable guidewire microrobot developed by Professor Hongsoo Choi 's team in the Department of Robotics Engineering at DGIST Credit: ©DGIST

A DGIST research team has developed a microrobot that can accurately reach the location of cardiovascular problems such as chronic total occlusion by moving and steering toward a desired direction inside blood vessels. This research is expected to increase the success rate of treatment and shorten the time of cardiovascular disease surgery.

Professor Hongsoo Choi's team in the Robotics Engineering Department, in collaboration with Professor Byung-Ju Yi's team at Hanyang University and Professor Bradley J Nelson's team at Technische Hochschule Zürich in Switzerland, developed the magnetically controlled microrobot, which can enhance the success rate of CTO treatment among myocardial infarctions.

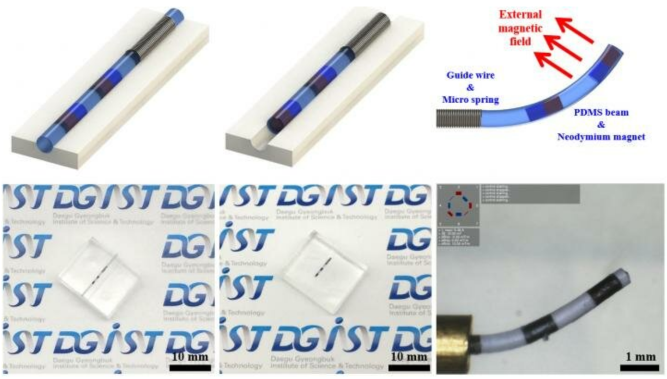
Since the guidewire used for percutaneous coronary intervention, which opens up obstructed blood vessels, is controlled manually by a surgeon to change its direction and location, the success rate and speed of surgery depended on the surgeon's skill. It was difficult to control the exact location and direction, as the surgeon had to set and push the guidewire manually with bent ends inside complex blood vessels or junction.

To overcome this limitation, Professor Choi's team applied a flexible and biocompatible polymer and a neodymium magnet that can control the direction and location with an external magnetic field. The team developed a cylindrical microrobot with a diameter of 500um and length of 4mm and attached it at the end of guidewire. They also developed an attachable guidewire soft microrobot to steer the guidewire toward a desired direction by controlling it with the external magnetic field and enabling a rectilinear motion through a "master-slave" system.

The research team also mathematically calculated the microrobot's flexible, nonlinear motion, and penetrated the complex blood vessels through a "feedforward" method. The team also succeeded in an experiment to reach a desired area in a 3-D blood vessel model that imitates the coronary artery of heart and the biocompatibility of microrobot from a cell survival experiment.

The robot can reach a desired area inside the complex blood vessel more quickly than previous techniques, which will increase the success rate and efficiency of surgery. It will also reduce the exposure of the patient and surgeon to X-ray radiation, as well as blood vessel damage, as it can reach the damaged site more quickly than the existing method.

Professor Hongsoo Choi in the Department of Robotics Engineering said, "Compared to the existing method, using an attachable guidewire microrobot will shorten the time for heart disease surgery and increase the success rate by enabling the surgeon to find the cause of disease more accurately and quickly for a stable surgery. Our research team will work harder to conduct follow-up research with related companies and develop products that can be used in medical sites."



Manufacturing process and concept map of attachable guidewire microrobot, actually manufactured microrobot Credit: ©DGIST

More information: Sungwoong Jeon et al, A Magnetically Controlled Soft Microrobot Steering a Guidewire in a Three-Dimensional Phantom Vascular Network, *Soft Robotics* (2018). DOI: 10.1089/soro.2018.0019

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