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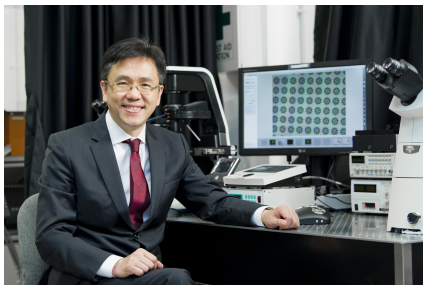
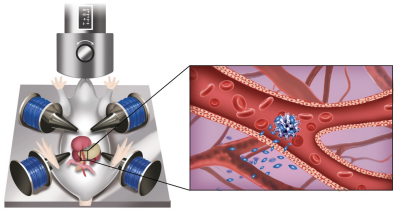
Magnetic Microrobotic System for Precise Cell Delivery in Vivo

Health & Wellness

Biomedical and Genetic Engineering





Remarks
Inventions Geneva Evaluation Days (IGED) 2021 - Silver Medal

IP Status
Patent granted

Technology Readiness Level (TRL) 7

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Opportunity

Precise delivery of cells to the desired site in vivo is a major challenge in precision cell therapy today. Traditionally, cell delivery has relied on blood circulation. In this way, only a few cells can reach their target sites, so a large number of cells must be used. This situation can lead to a severe and excessive immune response caused by overproduction of cytokines. This condition leads to severe and excessive immune response caused by cytokine overproduction. This problem can be solved by the precise delivery of therapeutic cells carried by a microrobot that is remotely driven by an external magnetic field. This emerging technology will allow many new and unforeseen clinical applications that were previously considered impossible and will have a profound impact on the precision medical treatment.

Technology

An advanced microrobotic prototype system was developed to actuate magnetically powered microrobots, which can carry and deliver therapeutic cells in vivo to advance precise target therapy. The system is based on intelligent microrobots carrying and releasing cells, an electromagnetic coil system for microrobot actuation, and photoacoustic imaging technology for guiding the microrobots to navigate in the body. By using the developed system, a preclinical application of using magnet-driven microrobots to deliver engineered stem cells to cure liver cancer treatment was successfully conducted on mice. As reported by Science Robotics (2018) and Small (2020), this is the world's first proof-of-concept demonstration of using magnetic microrobots to achieve precise delivery of cells in the body and preclinical applications on living animal. The project received the award of 2019 China's Top Ten Scientific and Technological Development in Intelligent Manufacturing.

Advantages

- The degradable porous spherical microrobot with spine structure, manufactured by 3D laser lithography, has high cell loading capacity and

can reduce the resistance from the blood flow. (pending US Patent 15/702,462 and US 63/055,963)

- An electromagnetic actuation system with a novel core shape design to enhance gradient (pending US Patents 16/406); 3D image reconstruction capability can precisely control the microrobots in complex in vivo environments in a non-invasive way (pending US Patent US 16/406, 134)
- Photoacoustic imaging guides the automatic navigation of microrobots in vivo, with advantages of large penetration depth, high imaging resolution, and good real-time performance. (US Patent 2018/0303349 A1)

Applications

With this emerging technology, cells can be safely, accurately and quantitatively delivered to the targeted site of the body. Some typical applications conducted by us include:

- Target treatment of cancers: We have reported a preclinical study of delivering engineered stem cells to the site of the tumor implanted in the orthotopic liver of nude mouse. The study will be expanded to human clinical trials in the future.
- Articular cartilage regeneration: We are conducting a study of delivering mesenchymal stem cells to cartilaginous defects of animals to repair articular cartilage while exploring the possibility of human clinical trials.