Trojan Microrobots for Digestive Tract Treatment

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Oral administration is a common drug delivery way in our daily lives. However, achieving precise target delivery and ensuring medication efficacy in the digestive system with complex pH environments is challenging. Motivated by the "Trojan Horse" story, we proposed a multilayer magnetic hydrogel oral "Trojan Microrobot" for on-demand release driven by a gradient magnetic field. The inner hydrogel shells enclosed designated drugs and magnetic microparticles. The outer hydrogel shells enclosed the inner hydrogel shells, magnetic microparticles, and pH neutralizers. Fabricated by the hanging drop method, the spheroid microrobots have a size of 1-3 mm, facilitating oral medicine delivery. Inspired by creatures rolling on the ground, the robots were driven to move via surface rolling, realized by a rotating gradient magnetic field produced by a five-axis motion platform carrying a rotating magnet. In-vitro and ex-vivo experiments were performed to demonstrate the rolling microrobots with well-controlled movement direction and destination and their disintegration layer by layer, which relied on the ratio of the fabrication materials. The biosafety test was conducted by co-culturing with zebrafish embryos, revealing the safety of the microrobots for living organisms. The microrobots can deform to pass through narrow channels via deformation and stay stable in acid and alkaline in-vitro environments. The robots can also be controlled to deliver and release containers in a bovine intestine ex-vivo. These results revealed the advantages of the Trojan microrobot in cargo delivery with almost no loss, remote controlled release, and less damaged drugs by pH environment. It is a promising approach to advance next-generation precision oral therapies in the digestive system in vivo.

Awards Won:
Fourth Award of $500