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Engineering Embolization Particles with Uniform Shape and Size

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Extended Abstract

Embolization therapy is a nonsurgical, minimally invasive procedure that involves the selective occlusion of blood vessels by purposely introducing embolization microparticles. It has become a major branch of modern interventional therapy, its applications fundamental in treating a wide variety of conditions affecting different organs of the human body including tumors, hemorrhages and vascular anomalies. To obtain good clinical outcomes and minimize complications, embolization particles must be uniform in shape and size. To date, the functional outcomes of existing embolic particles have not been satisfactory due to the inadequacies of conventional fabrication approaches in engineering their shape, size and microstructures.

We are developing an approach for precise fabrication of embolization microparticles that are uniform in shape and size. The key is to replace the "top-down" bulk process used in conventional approaches with a "bottom-up" microfluidic process of polymer cross-linking. The proposed approach uses either a single-phase or a two-phase microfluidic device to generate micro droplets containing the particle material, exploiting the capability offered by microfluidics to precisely handle small fluid volumes and accurately control formation of droplets. Cross-linker solution is used for droplet solidification in either off-chip or on-chip manner. These methods allow control over the formation of individual particles and enable the generation of highly uniform particles. We are developing and characterizing the approach for fabricating uniform embolization microparticles with two biocompatible materials: polyvinyl alcohol (PVA) and sodium alginate. The success of the project will offer embolization particles which will help set new standards for control, precision and ease of use in the treatment of many conditions and diseases such as uterine fibroids and liver cancers.