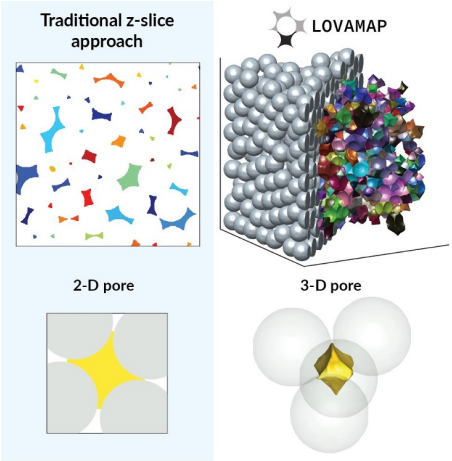

Void space and scaffold analysis of packed particles

Unmet Need

Granular materials are used in countless contexts and are appealing for several applications in biomedical engineering, including injectable tissue mimics and 3-D bioprinting. Packed microgel particles form granular scaffolds, which have been used for therapeutic applications in wound healing in part because of the micro-porosity that is formed between particles. This interconnected void space allows for unhindered cell infiltration and migration throughout the scaffold. Many studies have demonstrated that local geometry influences cell behavior, and in granular scaffolds, residing cells sense the microarchitecture of the void space. The structure of this space is challenging to study, leading to reports of unreliable void volume fraction measurements and/or 2-D z-slice approximations of 'pore size' as the primary void space metrics. In order to improve material design, there is a need to characterize the 3-D internal geometry of granular scaffolds both accurately and holistically.

Technology

Duke inventors have developed LOVAMAP, a custom software that analyzes geometrical features of 3-D packed particles. Specifically, LOVAMAP takes in packed particle data and segments the void space into '3-D pores,' which are the natural open pockets of space. This is achieved using an approach termed Medial Axis by Particle Configuration (MAPC), which is a highly effective basis for extracting information about the medial axis of the void space. LOVAMAP then performs measurements that provide the user with a quantitative profile of the granular scaffold, covering topics such as pore size and shape, connectivity, paths, isotropy/anisotropy, ligand availability, and infiltration/migration restrictions. Using higher dimensional analysis, LOVAMAP outputs are used to identify and classify types of 3-D pores in a given scaffold, and they also serve as a quantitative 'fingerprint' by which to classify types of scaffolds. This software has been used to study actual annealed microparticle scaffolds that contain neurospheres. In conjunction with cell data, LOVAMAP revealed relationships between neurosphere formation and scaffold void space geometry.

Advantages

- Accurate identification of 3-D pores in granular scaffolds
- Breadth of void space and scaffold metrics
- Classification of 1) granular scaffold types, 2) 3-D pore types
- Accurate identification of medial axis (MA) and MA-subtypes in void space of packed particles
- Increased predictability of scaffold viability for cell growth
- Ability to correct or improve granular material design

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Publication(s)

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External Link(s)

• From the lab of Dr. Tatiana Segura