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3D Printing Assisted Prototyping of Anatomically Accurate Aortic Valve Alginate Scaffolds

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Within the field of biomedicine, the scope of alginate application is broad and includes: wound healing, cell transplantation, delivery of bioactive agents such as chemical drugs and proteins, heat burns, acid reflux, and weight control applications. Recently the alginate based biomaterials for the treatment of myocardial infarction are entering into the advanced clinical trials stage. The non-thrombogenic nature of this polymer has made it an attractive candidate for cardiac applications, including scaffold fabrication for heart valve tissue engineering. The next pivotal property of alginates is their ability to form films, fibers, beads and virtually any shape in a variety of sizes. Moreover, alginates could form the gels in mild conditions, for example by adding calcium salt to an aqueous solution of alginate. The calcium ions displace the sodium from the alginate, and grasp the long alginate molecules together, resulting in a gel. This property is a base for obtaining the alginate scaffold with complex geometry of the aortic heart valve, in a few easy steps. These steps could be freely adjusted to yield the structure consenting precisely allocated viable cells. Alginate scaffold preparation was carried out by immersing the agarose mold saturated in $CaCl_2$ solution (2% w/w). The calcium ions diffused form the mold and cross-linked alginate, subsequently the mold was removed. Obtained structure closely matched the mold geometry. The mold was made by casting the agarose into the 3d printed form. Moreover by extending the time of mold immersion into the sodium alginate solution, the thickness of scaffold and its composition can be controlled. The details of the process are discussed in this report. The drawback of alginate is that it yields relatively soft mechanically unstable structures. As reported elsewhere, that could improve if the scaffold will be saturated with viable proliferating cells. Alternatively the hydrogel can be reinforced by polymeric yarns.

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