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Architected Cardiovascular Implants for Accommodating Growth

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Right ventricle–to–pulmonary artery (RV-PA) conduits are frequently used as a surgical palliative treatment for a variety of congenital heart diseases in infants and children [1]. Due to the growth of the infant or child, these conduits require replacement as they cannot grow, which involves several major open-heart surgery before adulthood [2-5]. To address this issue, we have investigated a novel architected RV-PA conduit that "grow" via tailored self-unfolding mechanisms triggered by flow and time so that fewer complications as well as surgeries are required to maintain and develop normal pulmonary blood flow from infancy to adulthood. We will present our numerical simulation results for design of architected implants to control their shape changes as the flow rate increases with the growth of a child. We will also present our experimental results of testing 3D printed architected implant devices using an in-vitro set-up that can simulate pulsatile flow changes with the growth of a person to characterize the behaviors of architected implants for verification of our design. Both numerical and experimental data show that our architected implant devices can match the required shape changes to accommodate the growth of children by increasing the dimensions of the devices by self-unfolding mechanism. We anticipate that our architected RV-PA conduit will result in operation of the conduits over longer periods of infant and child growth into adulthood. The findings from our study can also contribute to other types of implant devices that require customized deformation/shape change mechanisms by the interplay between geometry and material.

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