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International Journal of Bioprinting

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Three-Dimensional bioprinting of *in vitro* full-thickness skin model incorporating the rete ridge structure

Article ID: IJB3961

Citation: Jang I, Kim JH, Kim M, et al. Three-Dimensional bioprinting of in vitro full-thickness skin model incorporating the rete ridge structure. *Int J Bioprint*. 2024. doi: 10.36922/ijb.3961

AccScience Publishing
RESEARCH ARTICLE
Volume X Issue X (2024)
doi: 10.36922/ijb.3961

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Supplementary File

Supplementary results

Validation of computational fluid dynamics method

To ensure the reliability of the computational fluid dynamics (CFD) method used in this study for the design of a precursor cartridge for fissure structure printing, experimental results were compared with CFD simulations for precursor cartridges with core-shell structure as described in Figure S1. The cartridges were fabricated to fit into 3 mL syringes, with cores designed to have diameters of 1.4, 1.7, and 2.0 mm respectively. The alginate solution was filled into the core compartment, while the skin-derived decellularized extracellular matrix (SdECM) was filled into the shell compartment, and strands were extruded using an 18G nozzle. Simultaneously, CFD simulations were conducted for the same model. As alginate does not crosslink within the strand, observation of the cross-section revealed lumens formed within the strands composed of SdECM. Comparison of the ratio of lumen area in the entire strand with the ratio of alginate solution within the simulation revealed highly similar results. Therefore, these results suggest that the CFD method utilized in this study can effectively predict the outcomes of the preset extrusion bioprinting process.

Supplementary Figures

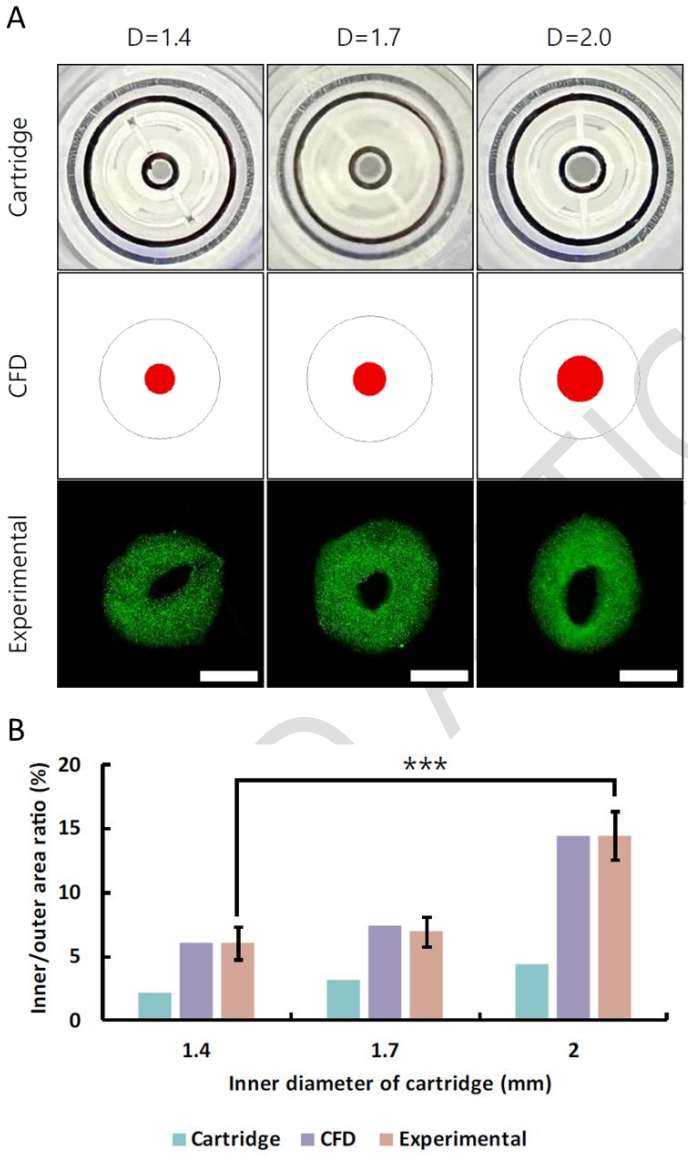

Figure S1. Comparison of CFD and experimental results to ensure the reliability of the CFD method with core-shell architecture. (A) Images of precursor cartridge architecture along with CFD results and experimental results. (B) Results of the calculations of the proportion of alginate solution within the overall area, encompassing SdECM, in the precursor cartridge, CFD method, and experimental outcomes.

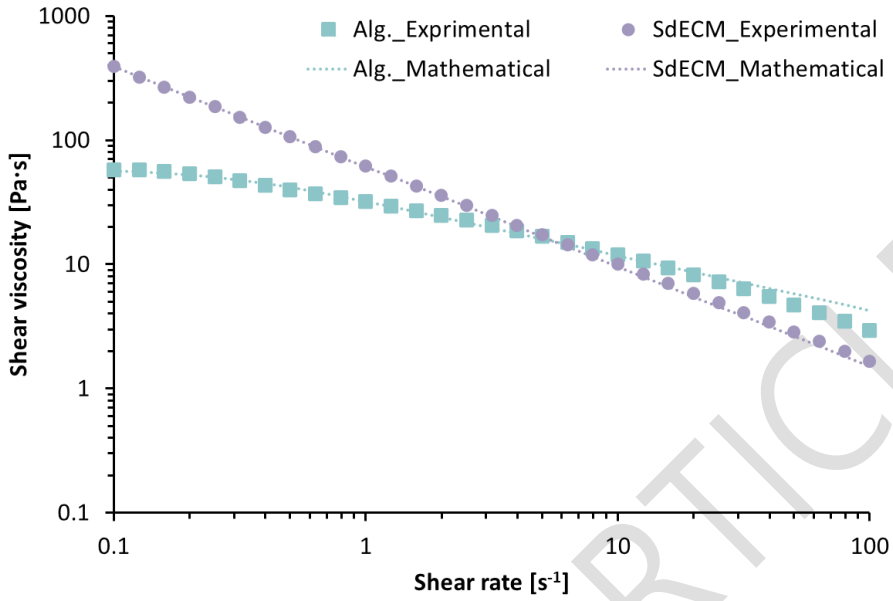

Figure S2. Shear viscosity profile of the 2.75% alginate solution and 3.25% SdECM bioink. The markers denote the measured value by rheometer, while the dashed line represents the trend line.

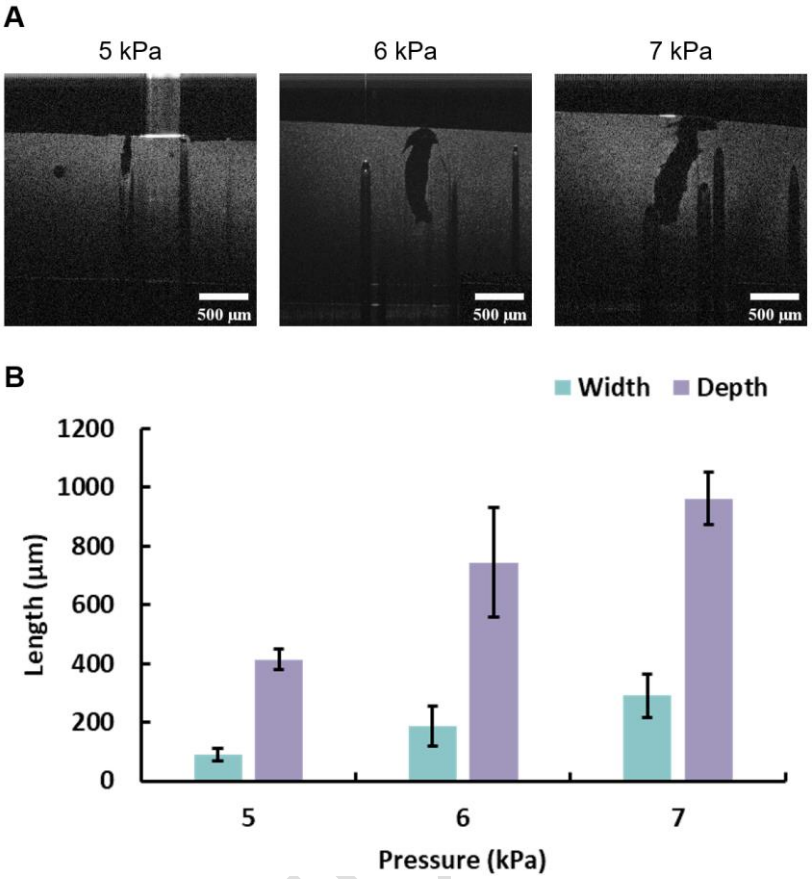

Figure S3. (A) Cross-sectional image of the printed structure using OCT. (B) Measured dimension of width and depth in printed structure

Supplementary Tables

Table S1. Mathematical models of viscosity for the alginate solution and SdECM bioink.

	Alginate solution	**SdECM bioink**
Mathematical model	Carreau model; $\mu=57.78\times\left[1+0.369\times\dot{\gamma}^{2}\right]^{-0.221}$	Power model; $\mu=61.08\times\dot{\gamma}^{-0.804}$
R-Square	0.9966	0.9997