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3D-printed endothelium-mimicking blood-contacting surfaces with anti-thrombogenic and anti-bacterial properties

Kabirian F. (1,2), Ditkowski B.(1), Zamanian A. (2), Hoylaerts M.F. (3), Mozafari M. (2), Heying R. (1)
(1) Pediatric Cardiology, Cardiovascular Developmental Biology, KU Leuven, Leuven, Belgium;
(2) Nanotechnology & Advanced Materials Department, Materials & Energy Research Center (MERC), Tehran, Iran;
(3) Center of Molecular and Vascular Biology, Department of Cardiovascular Sciences, KU Leuven, Leuven, Belgium

Background: Custom made, cardiovascular grafts are of advantage in the treatment of children with congenital cardiovascular defects in which the anatomy varies. 3D-printing is an inexpensive, accurate, and simple method which can help surgeons to design and print the grafts according to radiographical images. Thrombogenicity and bacterial infectiveness are the most common complications for foreign blood contacting surfaces associated with functional failure of the grafts.

Method: A 3d-printed model of blood vessel was designed and printed. A novel coating was designed to release NO in a controlled manner and in the physiological range of NO release comparable to that from the endothelium (0.5 - 4.0 × 10−10 mol.cm−2.min−1) to cover the 3d-printed graft. This coating was prepared by blending of S-nitroso-N-acetyl-D-penicillamine (SNAP) in a polymeric substrate created from polycaprolactone (PCL) and polyethylene glycol (PEG).

Results: Coating the 3D-printed grafts with PEG-PCL-SNAP resulted in quantitative anti-bacterial features against both Gram-positive and Gram-negative bacteria and in NO-mediated inhibition of platelet aggregation in the range of 14 days. Anti-bacterial and anti-thrombogenic properties in plasma are expected to be as effective as in PBS since NO release in plasma was not significantly different from that in PBS.

Conclusion: The application of NO-releasing form 3d-printed vascular grafts is promising for the engineering of vascular grafts showing bactericidal and anti-thrombogenic properties.