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materials-driven regeneration

- Wednesday March 8, 2023 -

- 4:00pm (CET) -

MDR colloquium March 2023

Online – TEAMS meeting

The Research Center for Materials-Driven Regeneration (MDR) is proud to present a series of lectures (monthly). The MDR Gravitation program is a partnership between Eindhoven University of Technology, Maastricht University and Utrecht University, University Medical Center Utrecht and the Hubrecht Institute. MDR brings together materials scientists, cell biologists, tissue engineers and medical scientists to jointly work on the regeneration of tissue and organ function with intelligent, life-like materials.

Kidney-on-a-chip models to study human renal (patho-) physiology: a systematic review

With the increasing incidence of kidney disease, now affecting around 10% of the world population, the importance to understand disease mechanisms and develop therapeutic interventions is higher than ever. Therefore, apart from clinical studies, representative laboratory models are essential. Although well-established animal models have significantly enhanced knowledge on disease mechanisms, it has become clear that human (patho-)physiology may not be adequately represented. Recent developments in microfluidics and in vitro renal cell biology have enabled the development of kidney-on-a-chip (KoC) models, dynamic models to study the (patho-)physiology of the kidney in the laboratory. With the possibility to include human cells and combine different organ models, such platforms are powerful tools to help refine and reduce animal experiments. Here, we systematically review the methodological quality, clinical applicability, effectiveness and safety of KoC models and multi-organ-on-a-chip (MOC) models combining the kidney. We describe the state-of-the-art and aim to identify strengths, limitations, and opportunities regarding basic research and implementation of these models. We conclude that KoC models have evolved to complex models combining multiple human organ models capable of mimicking systemic (patho-)physiological processes. The introduction of commercial chip platforms and use of human induced pluripotent stem cells and organoids is becoming more dominant in the establishment of KoC and kidney-based MOC models to study disease mechanisms and assess drug efficacy and toxicity, even in a personalized medicine setting. These developments offer great promise towards the Reduction, Refinement and Replacement of animal models in kidney and drug research. However, currently the implementation of these models appears to be hampered by a lack of reporting on intra- and inter-laboratory reproducibility and translational capacity.

Vivian Nguyen

University Medical Center Utrecht

Prediction of thrombus formation in arterial stent

After balloon angioplasty in arteries, stents are implanted to maintain the vessel's dilation and ensure its patency. However, stent geometry, including the inter-strut spacing, length, and strut cross-section, affects stent-vessel interactions and alter blood flow patterns. In addition, poor stent design can increase particles residence time, create low wall shear stress and promote coagulation. Furthermore, the struts could bring the risk of inflammation due to endothelial damage, intimal thickening, and thrombus formation. Assessing high risk geometrical features for thrombus formation and evaluating strategies for preventing thrombosis are essential in designing effective stents.

Platelets play a crucial role in haemostasis and clot formation. They bind to the damaged endothelial cells through the processes of aggregation, activation, and adhesion. Additionally, in high shear flows von Willebrand factor (vWF), a protein that is sensitive to mechanical stress and hemodynamic forces, undergoes a conformational change to bind to collagen and platelets through A1 and A3 binding domains, respectively. Thus, the combined effect of platelet activation due to collagen exposure and unfolding vWF due to hemodynamic alteration could start the thrombus formation in stents. The aim of the current study is to quantify the mechanisms, underlie thrombus formation in stents in order to find means to prevent serious complications and maintain long-term patency.

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