Guo Xiaobo, J Coron Heart Dis 2025, Volume 09

A novel pressure-perfusion tissue culture system for invitro vascular cultivation to simulate the hemodynamic environment after coronary artery bypass grafting

Guo Xiaobo
Capital Medical University, China

Statement of the Problem: Vein graft failure (VGF) remains a major clinical challenge following coronary artery bypass grafting (CABG), significantly affecting long-term graft patency. Intimal hyperplasia (IH) is a key pathological process contributing to VGF, primarily triggered by the altered hemodynamic environment post-CABG. Despite extensive studies using animal models, an efficient and physiologically relevant in vitro system to investigate human saphenous vein (SV) pathology under arterial conditions is still lacking. This study aims to develop a novel pulsatile pressure-perfusion vessel culture system (VVCS) to simulate the post-CABG pressure environment and investigate the structural changes in human SV grafts under controlled conditions. Methodology & Theoretical Orientation: A custom-designed VVCS was established to maintain SV samples under pulsatile arterial pressure (80/120 mmHg) for 14 days under sterile conditions. The system was optimized to ensure histocompatibility, real-time pressure monitoring, and minimal contamination risk. Histological analysis, including hematoxylin-eosin (HE) staining, CD31 immunostaining, and Verhoeff-van Gieson (EVG) staining, was performed to assess endothelial integrity, intimal changes, and structural remodeling. AI-assisted image analysis was applied to quantify endothelial cell (EC) coverage and intimal thickening. Findings: Following 14 days of culture under CABG-like conditions, SV grafts exhibited significant morphological alterations, including lumen dilation, reduced wall thickness, muscle fiber rearrangement, and mild fibrosis. While EC coverage showed no statistically significant difference before and after culture ($P = 0.473$), a notable increase in intimal thickness was observed (mean thickening rate: 5.08%, $P < 0.001$). These results suggest that while arterial pressure alone may not induce immediate endothelial damage, it contributes to early structural remodeling associated with IH. Conclusion & Significance: The VVCS offers a cost-effective, reproducible, and physiologically relevant tool for investigating vascular remodeling and optimizing strategies to prevent vein graft failure in CABG patients.

Recent Publications

1. Prim, D. A. (2021) Evaluation of the Stress–Growth Hypothesis in Saphenous Vein Perfusion Culture. Ann. Biomed. Eng. 49, 487–501 (2021).
2. Wang, J. (2021) An ex vivo physiologic and hyperplastic vessel culture model to study intra-arterial stent therapies. Biomaterials 275, 120911.

3. Ward, A. O. (2020) NF-κB inhibition prevents acute shear stress-induced inflammation in the saphenous vein graft endothelium. Sci. Rep. 10, 15133.

4. Knox, C. (2023) A Biomimetic Approach Utilizing Pulsatile Perfusion Generates Contractile Vascular Grafts. Tissue Eng. Part A 29, 358–371.

5. Helms, F. (2024) An Arteriovenous Bioreactor Perfusion System for Physiological In Vitro Culture of Complex Vascularized Tissue Constructs. Bioengineering 11, 1147.

Biography

Guo Xiaobo is a distinguished cardiac surgeon with extensive experience in coronary artery bypass grafting (CABG) and a longstanding commitment to preventing and treating vein graft restenosis. His expertise spans both clinical practice and translational research, focusing on optimizing graft longevity and improving surgical outcomes. Recognizing the limitations of existing models for studying vein graft pathology, Dr. Guo pioneered the development of the Vessel Culture System (VVCS)—a novel in vitro platform designed to simulate the hemodynamic environment of saphenous vein grafts post-CABG. His work integrates principles of vascular biology, biomechanics, and precision medicine to better understand graft remodeling and intimal hyperplasia. With years of experience in surgery, research, and medical innovation, Dr. Guo's contributions provide valuable insights into vascular graft preservation, offering new strategies to enhance graft patency and improve patient prognosis. His research continues to bridge the gap between bench and bedside in cardiovascular medicine.

Received: 16 May, 2025; **Accepted**: 19 May, 2025; **Published**: November 28, 2025