nature communications

Article

https://doi.org/10.1038/s41467-025-58056-2

Electronic vascular conduit for in situ identification of hemadostenosis and thrombosis in small animals and nonhuman primates

Received: 5 April 2024

Accepted: 11 March 2025

Published online: 18 March 2025

Check for updates

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Patients suffering from coronary artery disease (CAD) or peripheral arterial disease (PAD) can benefit from bypass graft surgery. For this surgery, arterial vascular grafts have become promising alternatives when autologous grafts are inaccessible but suffer from numerous postimplantation challenges, particularly delayed endothelialization, intimal hyperplasia, high risk of thrombogenicity and restenosis, and difficulty in timely detection of these subtle pathological changes. We present an electronic vascular conduit that integrates flexible electronics into bionic vascular grafts for in situ, real-time and long-term monitoring for hemadostenosis and thrombosis concurrent with postoperative vascular repair. Following bypass surgery, the integrated bioelectronic sensor based on the triboelectric effect enables monitoring of the blood flow in the vascular graft and identification of lesions in real time for up to three months. In male nonhuman primate cynomolgus monkeys, the electronic vascular conduit, with an integrated wireless signal transmission module, enables wireless and real-time hemodynamic monitoring and timely identification of thrombi. This electronic vascular conduit demonstrates potential as a treatment-monitoring platform, providing a sensitive and intuitive monitoring technique during the critical period after bypass surgery in patients with CAD and PAD.

Owing to the growing elderly population, the prevalence of vascular diseases has risen substantially[1–3]. Arterial vascular grafts, particularly small-diameter grafts with internal diameters <6 mm, have important implications for coronary artery bypass graft (CABG) surgery, peripheral artery reconstruction, and arteriovenous fistula creation, but suffer from problems related to slow endothelialization, which frequently results in platelet adhesion and initiation of the blood coagulation cascade[4–7], inducing thrombus formation and restenosis. According to clinical data, 10–15% of patients suffer from early graft dysfunction within 30 days after CABG surgery. Moreover, there is a

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