Nature Portfolio Reporting Summary

Journal: Nature Biomedical Engineering
Manuscript Title:
A Sustained Electronic Signaling Platform for Restoring Vascular Sensitivity and Systemic Homeostasis in Enzyme-Deficient Environments

1. Statistics and Software
Sample size:
Sample sizes (n = 6 for SHR rats and eNOS−/− mice; n = 15–20 for zebrafish models) were determined based on prior literature and power analysis to ensure sufficient statistical power (>80%) for detecting significant differences ($P < 0.05$).

Data exclusion: No data were excluded from the final analysis.
Replication:
All experimental findings were replicated in at least three independent experiments. Replication attempts were consistent across all datasets.
Randomization: Animals and zebrafish larvae were randomly assigned to experimental groups using a computer-generated randomization protocol.
Blinding: Investigators were blinded to group allocation during data collection (e.g., blood pressure measurements, behavioral tracking) and histological analysis.

Software and code:
Statistical analysis: GraphPad Prism 9.0 and Microsoft Excel 2021
Image processing: ImageJ (FIJI) for fluorescence quantification
Behavioral analysis: ViewPoint Zebrabox system for zebrafish locomotion
Spectroscopic analysis: OriginPro 2022 and Thermo Scientific Avantage (XPS analysis)

2. Data Availability

Data availability statement:

The datasets generated and/or analyzed during this study are available from the corresponding author upon reasonable request. Source data for all figures and supplementary figures are provided with the manuscript.

3. Field-Specific Reporting (Life Sciences)

Experimental design:

This study employed a randomized, controlled, and longitudinal design across multiple disease models, including hypertension, Parkinson's disease, colitis, and lung cancer.

Ethics:

All rodent experiments were approved by the Institutional Animal Care and Use Committee (IACUC) of Northeast Ohio Medical University (NEOMED) and Jeju National University.

Zebrafish experiments were conducted in accordance with the guidelines of the Animal Ethics Committee of SZEFIT Co., Ltd.

Laboratory animals:

SHR rats: Spontaneously hypertensive rats, male, 12 weeks old

eNOS−/− mice: C57BL/6J background, male, 10–12 weeks old

Zebrafish: Danio rerio (AB strain), larvae at 3–7 days post-fertilization (dpf)

4. Methodology (Physical Characterization)

Characterization methods:

XPS: Surface chemical analysis was performed using a Thermo Scientific Nexsa G2 system with an Al K-alpha source

ESR: Paramagnetic signals were measured using a JEOL JES-FA200 X-band EPR spectrometer at room temperature

EIS: Electrochemical impedance spectroscopy was conducted using a Bio-Logic VSP-300 workstation in a three-electrode configuration

GPC: Molecular weight distribution was analyzed by the Korea

Polymer Testing & Research Institute (KOPTRI) using a refractive index detector