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Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☐	☒	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Data in Figs. 1b,c and 2c were collected and recorded by NanoSight NS300 NTA software (Malvern). Data in Figs. 1d and 1e were conducted using a TOF SIMS V (ION TOF, Inc. Chestnut Ridge, NY). Data in Supplementary Fig. 3 was collected by curve-fitting program (CasaXPS, Version 2.3.17PR1.1). Data in Fig. 4d–j and Supplementary Fig. 8 were collected and analysed using Image-Pro Plus 7.
Data analysis	Data was analyzed using GraphPad Prism v7.0. PCR data was analyzed using PrimePCR Analysis Software (GeneStudy_1.0.030.1023, Bio-Rad). The immunohistochemistry was analyzed by Fiji Imagej.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The main data supporting the results in this study are available within the paper and its Supplementary Information. The raw and analysed datasets generated during the study are too large to be publicly shared, yet they are available for research purposes from the corresponding authors on reasonable request. GeneQuery rat-macrophage-polarization-markers qPCR-array data are available on the NCBI database with the identifier GSE155793. ToF-SIMS, XPS and histopathological data are available on reasonable request.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	We used a sample size of 3 for characterizing the morphology (Figs. 1b–f, Supplementary Fig. 3) and for the in vitro release studies (Figs. 2b–d). We used a sample size of 5 for in vitro biocompatibility and cell studies (Figs. 2e–h, 3b–m, and Supplementary Figs. 4 and 5). 3 rats per group were used for the biodistribution study (Supplementary Fig. 7). 10 rats per group were used for studies in Sprague Dawley rats with renal ischaemia-reperfusion injury (5 sacrificed on Day 7 and 5 sacrificed on Day 28; Figs. 4, 5, and Supplementary Figs. 8 and 9). 12 rats per group were used for studies in APOE–/– rats (6 sacrificed on Day 7 and 6 sacrificed on Day 28; Figs. 6, 7, and Supplementary Figs. 12 and 13).
Data exclusions	No data were excluded from the in vitro studies. The following exclusion criteria were pre-established: rats that did not survive the renal ischaemia-reperfusion surgery.
Replication	Each experiment described was designed to maximize the use of a single stent. Technical replicates are indicated in the figures. The results were consistent and replicable.
Randomization	All samples and animals tested were selected randomly.
Blinding	All imaging and measurements were conducted by an independent operator. The data analyser was independent from the experimenters.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☐	☒ Antibodies
☐	☒ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used	Anti-Von Willebrand Factor antibody (ab6994) (vWF, ABCAM), Anti-alpha smooth muscle Actin antibody (ab7817) (α-SMA, ABCAM), Anti-Ki67 antibody (ab15580) (ABCAM), Rhodamine labeled Lens Culinaris Agglutinin (LCA, VECTOR LABORATORIES, INC.), CD81 antibody (sc-166029, Santa Cruz Biotechnology), Anti-ALIX antibody (ab186429, ABCAM), TSG101 antibody (NB200-112, NOVUS Biologicals), Anti-CD68 antibody (ab955) (ABCAM),), Anti-Dystrophin (ab15277, ABCAM), Anti-Glucose Transporter GLUT1 (ab40084, ABCAM), Anti-Mannose Receptor (ab64693, ABCAM), Anti-MHC Class II (ab23990, ABCAM), Anti-CD31 (ab119339, ABCAM) Anti-VE Cadherin (ab7047, ABCAM). Goat Anti-Rabbit IgG H&L (Alexa Fluor 488) (ab150077), Goat Anti-Mouse IgG H&L (Alexa Fluor 488) (ab150113), Goat Anti-Mouse IgG H&L (Alexa Fluor 594) (ab150116).
Validation	vWF: https://www.abcam.com/von-willebrand-factor-antibody-ab6994.html α-SMA: https://www.abcam.com/alpha-smooth-muscle-actin-antibody-1a4-ab7817.html Ki67: https://www.abcam.com/ki67-antibody-ab15580.html Rhodamine labeled Lens Culinaris Agglutinin: https://vectorlabs.com/rhodamine-labeled-lens-culinaris-agglutinin-lca.html. CD81: https://www.scbt.com/scbt/product/cd81-antibody-b-11 ALIX: https://www.abcam.com/alix-antibody-epr15314-n-terminal-ab186429.html TSG101: https://www.novusbio.com/products/tsg101-antibody-4a10_nb200-112 α-SA: https://www.abcam.com/sarcomeric-alpha-actinin-antibody-ea-53-ab9465.html

CD68: https://www.abcam.com/cd68-antibody-kp1-ab955.html
Dystrophin: https://www.abcam.com/dystrophin-antibody-ab15277.html
Glucose Transporter GLU1: https://www.abcam.com/glucose-transporter-glut1-antibody-spm498-ab40084.html
MHC Class II: https://www.abcam.com/mhc-class-ii-antibody-mrc-ox-6-ab23990.html
CD31: https://www.abcam.com/cd31-antibody-hec7-ab119339.html
VE-Cadherin: https://www.abcam.com/ve-cadherin-antibody-bv9-ab7047.html
Mannose Receptor: https://www.abcam.com/mannose-receptor-antibody-ab64693.html
Goat Anti-Rabbit IgG (Alexa Fluor 488): https://www.abcam.com/goat-rabbit-igg-hl-alexa-fluor-488-ab150077.html
Goat Anti-Mouse IgG (Alexa Fluor 488): https://www.abcam.com/goat-mouse-igg-hl-alexa-fluor-488-ab150113.html
Goat Anti-Mouse IgG (Alexa Fluor 594): https://www.abcam.com/goat-mouse-igg-hl-alexa-fluor-594-ab150116.html

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s)	Human primary umbilical vein endothelial cells (HUVEC, PCS-100-013), human primary aortic smooth muscle cells (SMC, PCS-100-012), primary coronary artery endothelial cells (HCAEC, PCS-100-020) and human bone marrow-derived mesenchymal stem cells (BMMSC, PCS-500-012) were obtained from ATCC. U937 human monocytes (85011440) were purchased from Millipore Sigma.
Authentication	Authentication of the cells was provided by ATCC and Sigma and validated by the expression of surface markers.
Mycoplasma contamination	All cells are tested negative for mycoplasma contamination.
Commonly misidentified lines (See ICLAC register)	No commonly misidentified cell lines were used.

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals	Sprague-Dawley rats (4 months old, male, 300–500 g) were purchased from Charles River Laboratories. ApoE–/– rats (8–week, male, 300–500 g) were purchased from Horizon Discovery and fed with a high-fat diet during the entire study.
Wild animals	The study did not involve wild animals.
Field-collected samples	The study did not involve samples collected from the field.
Ethics oversight	All procedures were approved by the Institutional Animal Care and Use Committee (IACUC) of North Carolina State University (protocol 19-811-B) and were compliant with the guidelines from the United States National Institutes of Health.

Note that full information on the approval of the study protocol must also be provided in the manuscript.