

Reporting Summary

Nature Portfolio 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 Portfolio 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 (<i>n</i>) 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 <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☒	☐ 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. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
☒	☐ 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 <i>d</i> , Pearson's <i>r</i>), 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	CT data were collected using Latheta LCT-200 (Hitachi). Cells were collected using BD FACS Aria II (Becton Dickinson) and autoMACS Pro Separator (Miltenyi Biotec Inc). In vivo dynamics of injected cells were collected using IVIS Spectrum CT (Perkin Elmer). Fluorescent images were captured on a nikon AI microscope run with NIS-Elements (Nikon). Elastica-Masson staining and immunostaining images were captured on a BX53 microscope (Olympus). 3D staining images were captured on a light sheet microscope, MuVi-SPIM CS (Luxendo). PCR data were collected using a digital droplet PCR (ddPCR) QX100 system (Bio-Rad). Fibers images of aorta were captured on a transmission electron microscopy, JEM-1011 (JEOL).
Data analysis	CT datasets were analyzed using the Osirix software (MD ver.5.8.2, Pixmeo SARL). Sorted cells were analyzed using BD FACS Diva (ver.8.0.1, Becton Dickinson). Quantitative analyses of in vivo dynamics of injected cells were performed using Living Image software (ver.4.5, PerkinElmer). Quantitative analyses of immunofluorescence images were performed using NIS-Elements (version 4.50, Nikon). Quantitative analyses of Elastica-Masson staining images were performed using Image J software (ver.1.52, https://imagej.net/Citing). 3D staining images were processed using an Image Processor (v3.5.0, Luxendo) and visualized using Imaris software (v9.5.1, Bitplane). Quantitative analyses of ddPCR were performed using QuantaSoft (ver.1.7, Bio-Rad). Fibers images were processed using an EM-Menu (version 4.0.8.35, Tietz Video and Image Processing Systems GmbH). Statistical analyses were performed using JMP Pro 17 software (SAS Institute Inc).

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 Portfolio [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 description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Source data underlying the Figures and Supplementary Figures are provided as Supplementary Data file. CT images are available at <https://www.scidb.cn/en/detail?dataSetId=f1b7da634c334aaca05609c88740d65b>. The datasets obtained from this study are available from the corresponding author on reasonable request.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender

NA

Population characteristics

NA

Recruitment

NA

Ethics oversight

NA

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

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](https://www.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

No sample size calculation were performed. We based our sample size on previously published studies by our department.

Data exclusions

Mice that died by aortic rupture before the first CT scan, that develop Stanford type A acute aortic dissection, that did not develop acute aortic dissection or that with a thrombosed false lumen were all excluded.

Replication

No replication were performed.

Randomization

Mice were divided into experimental groups randomly by the experimenter.

Blinding

Experimenters were not blind, the sphingosine-1-phosphate (S1P) data analysis was blind and all other data analysis was not blind. All data analysis steps were performed in the exact same way.

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
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

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

Antibodies

Antibodies used

Antibody details were described in method section.

rat anti-SSEA antigen-3 (SSEA-3) IgM antibody (1:1000; 330302, BioLegend)

rat IgM isotype control antibody (1:1000; 400801, BioLegend)

FITC-conjugated goat anti-rat IgM antibody (1:100; 112-095-075, Jackson ImmunoResearch)

anti-FITC MicroBeads (1:50; Miltenyi Biotec)

mouse anti- α SMA IgG antibody (1:200; MS-113, Thermo Fisher Scientific)

abbiit anti-GFP IgG antibody (1:500; MBL598, Medical & Biological Laboratories)

Alexa Fluor 680-conjugated donkey anti-mouse IgG antibody (1:500; A10038, Thermo Fisher Scientific)

Alexa Fluor 594-conjugated donkey anti-rabbit IgG antibody (1:500; 711-586-152, Jackson ImmunoResearch)

goat anti-CD31 IgG antibody (1:50; sc-1506, Santa Cruz Biotechnology)

Alexa Fluor 647-conjugated donkey anti-goat IgG antibody (1:500; 705-606-147, Jackson ImmunoResearch)

anti-mouse CD45 rat IgG2b antibody (1:10; 550539, BD Pharmingen)

horseradish peroxidase (HRP)-conjugated donkey anti-rat IgG antibody (1:500; 712-036-153, Jackson ImmunoResearch)

goat anti-GFP IgG antibody (1:100; ab6673, Abcam)

Alexa Fluor 488-conjugated donkey anti-goat IgG (1:200; 705-545-003, Jackson ImmunoResearch)

mouse anti-human HLA-G IgG1 antibody (1:200; 557577, BD)

goat anti-mouse IgG-HRP antibody (1:5000; 115-035-071, Jackson ImmunoResearch)

mouse anti-beta actin IgG1 antibody (1:10000; ab6276, abcam)

goat anti-mouse IgG-HRP antibody (1:5000; 115-035-071, Jackson ImmunoResearch)

mouse anti-HLA-G IgG2a antibody (1:50; 557577, BD)

mouse IgG2a isotype control antibody (1:50, 400201, BioLegend)

APC-conjugated goat anti-mouse IgG antibody (1:100; 115-136-146, Jackson ImmunoResearch)

Validation

All antibodies were commercially available and validated by the manufacturers, with cited references if applicable and accurately represented expression patterns.

Eukaryotic cell lines

Policy information about [cell lines and Sex and Gender in Research](#)

Cell line source(s)

Human bone marrow-derived mesenchymal stem cells (MSCs) were commercially available (PT-2501, Lonza, Basel) and MSCs were used as the source of Muse cells and non-Muse cells. LentiX-293T cells were obtained from TaKaRa Bio Inc. JEG3 cells were obtained from European Collection of Authenticated Cell Cultures (ECACC).

Authentication

Characteristics, morphology, pluripotency, self-renewal and differentiation abilities of Muse cells generated by similar methods were described in our previous papers (References No.11-29).

Mycoplasma contamination

Cells were not tested for mycoplasma contamination.

Commonly misidentified lines
(See [ICLAC](#) register)

No commonly misidentified cell lines were used in this study.

Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

Laboratory animals

Male 4-week-old wild-type mice (C57BL/6NCRs1c) were purchased from Japan SLC Inc.

Wild animals

No wild animals were used in this study.

Reporting on sex

Only male mice were used in this study because previous papers used only male mice (References No.30, 31), probably in order to exclude the effect of estrous cycle of female mice on aortic dissection.

Field-collected samples

No field-collected samples were used in this study.

Ethics oversight

All animal experiments were performed in compliance with the Animal Care and Use Committee of Tohoku University Graduate School of Medicine and animal care was carried out in accordance with the committee's guidelines.

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

Flow Cytometry

Plots

Confirm that:

- ☒ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).
- ☒ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).
- ☒ All plots are contour plots with outliers or pseudocolor plots.
- ☒ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation

Cells were harvested from the medium and resuspended in FluoroBrite DMEM Containing 0.5% bovine serum albumin and 2 mM EDTA. Then, the cells were incubated with antibodies on ice for 1 hour. After staining, cells were washed three times with suspension buffer and analyzed after adding BD Cell Viability kit.

Instrument

FACS Aria II with UV (355 nm), Violet (405 nm), Blue (488 nm), Yellow green (561 nm), Red (641 nm) lasers (Becton Dickinson).

Software

FACS Diva software version 8.0.1 (Becton Dickinson).

Cell population abundance

We did not concentrate the cell population.

Gating strategy

First, we used non-stain cells and isotype control cells to pull the gate and determine areas of negative population. We then collect the viable cells as the marker positive populations.

- ☒ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.