nature portfolio

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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 (*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	CaseViewer version 2.4 Laser Speckle Contrast Imaging System RFLSI III version 4.0 FUJI film FPD-8010E version 2.5.0.3 Tracker version 6.0.9
Data analysis	GraphPad Prism version 9.5.0 Thermo Science Amira 3D version 2021.1

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

All data supporting the findings of this study are provided in the paper, the Extended Data figures, and the Supplementary Information. Source data underlying the figures are available on GitHub at https://github.com/Slipknot-Gauged.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Participant selection was based solely on suitability for the research objectives, without consideration of sex or gender. Sex or gender information of participating surgeons was self-reported. For the knot-tying force test, 10 junior surgeons (9 male, 1 female) and 5 senior surgeons (all male) were recruited. For the bimanual knot-tying force test and the incision pressure test of standing sutures, 5 junior surgeons (3 male, 2 female) and 5 senior surgeons (all male) were recruited for each.
Reporting on race, ethnicity, or other socially relevant groupings	Participant selection was based solely on suitability for the research objectives, without consideration of race, ethnicity, or other socially relevant groupings for any of the tests, and no such data were self-reported by participants.
Population characteristics	For the knot-tying force test, surgeons are ranging in age from 23 to 44 years participated in this study. For the bimanual knot-tying force test and the incision pressure test of standing sutures surgeons are ranging in age from 28 to 45 years participated in this study.
Recruitment	All participating surgeons were randomly recruited without bias from the Department of General Surgery, Sir Run Run Shaw Hospital, Zhejiang University School of Medicine, Hangzhou, China. Junior surgeons were defined as those with less than 10 years of clinical experience, and senior surgeons as those with more than 10 years of clinical experience. All participants met the eligibility criteria. In the initial submission, 10 junior surgeons and 5 senior surgeons were randomly selected and recruited for testing. During the revision process, 5 junior surgeons and 5 senior surgeons were randomly recruited to perform the updated tests.
Ethics oversight	Ethics for the study was approved by the Institutional Review Board of Sir Run Run Shaw Hospital, Zhejiang University (Approval No. 2023-0528 and 2025-0023).

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

Life sciences study design

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

Sample size	No formal sample size calculation was performed, and the number of samples was determined by the maximum available resources. In animal experiments exploring the feasible force range, a sample size of n = 20 was used. For ex vivo and in vivo rat colonic defect repair, the sample sizes were n = 5 for ex vivo and n = 5 for in vivo experiments. For comparison of anastomotic complications, the sample sizes were n = 10 in the sliputure group and n = 10 in the control group. For comparison of wound healing, the sample sizes were n = 3 for each subgroup from D1–D8 in both the sliputure and control groups. Laparoscopic and robotic experiments were conducted with a minimum of one pig per group. No statistical methods were applied to calculate sample size.
Data exclusions	Data exclusion was considered when animals appeared sick.
Replication	Unless otherwise specified in the manuscript, all experiments were performed at least three times, either as replications or independent trials, and all replication results were confirmed to fall within the acceptable error range.
Randomization	The animal samples prepared by the same method were randomly allocated to each group.
Blinding	The data were not blinded. The same investigator conducted both the experimental and data analyses; therefore, blinding was not feasible.

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
☒	☐ Plants

Methods

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

Antibodies

Antibodies used	Anti-CD86 Rabbit mAb (Clone: E5W6H, 19589S, CST, 1:400), Anti-CD206 Mouse mAb (Clone: 2A6A10, 60143-1-ig, Proteintech, 1:5000).
Validation	All antibodies were validated by the manufacture. The details were shown at the manufacture's websites as indicated below: Anti-CD86 Rabbit mAb (19589S, CST, 1:400): https://www.cellsignal.cn/products/primary-antibodies/cd86-e5w6h-rabbit-mab/1958, Anti-CD206 Mouse mAb (60143-1-ig, Proteintech, 1:5000): https://www.ptgcn.com/products/MRC1-Antibody-60143-1-Ig.htm.

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	The study animals were: SPF (specific pathogen free) rats weighing 200 - 250 g, female, species: Sprague-Dawley rats, age: 4 weeks. Pigs weighing 23 - 27 kg, female, species: Bama miniature pig, age: 5 - 6 months.
Wild animals	No wild animals were used in the study.
Reporting on sex	All animals were female.
Field-collected samples	No field collected samples were used in the study.
Ethics oversight	The animal study was approved by the Institutional Animal Care and Use Committee at Zhejiang University (Approval No. ZJU20230084 and ZJU20250067).

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

Plants

Seed stocks	N/A
Novel plant genotypes	N/A
Authentication	N/A