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☐ Initial submission ☐ Revised version ☒ Final submission

Life Sciences Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form is intended for publication with all accepted life science papers and provides structure for consistency and transparency in reporting. Every life science submission will use this form; some list items might not apply to an individual manuscript, but all fields must be completed for clarity.

For further information on the points included in this form, see Reporting Life Sciences Research. For further information on Nature Research policies, including our data availability policy, see Authors & Referees and the Editorial Policy Checklist.

Experimental design

1. Sample size

Describe how sample size was determined.

Effect sizes were not known a priori, so sample sizes were instead set on the basis of our past experience for the technical development of pilot studies. Significant differences were found in the manuscript, implying adequate power.

2. Data exclusions

Describe any data exclusions.

In the patient study, two of 10 subjects had only five myocardial segments (instead of six) available for analysis, as the slice intersected the left ventricular outflow tract.

3. Replication

Describe whether the experimental findings were reliably reproduced.

The manuscript specifically addresses the repeatability of measurements.

4. Randomization

Describe how samples/organisms/participants were allocated into experimental groups.

Not applicable. Although there were two groups of subjects in the T1-T2 mapping section of the paper [1) healthy volunteers; 2) patients with acute myocardial infarction], the results from each group were analyzed independently of one another as separate substudies.

5. Blinding

Describe whether the investigators were blinded to group allocation during data collection and/or analysis.

Not applicable. Subjects from different groups were not compared to each other (see point #4)

Note: all studies involving animals and/or human research participants must disclose whether blinding and randomization were used.

6. Statistical parameters

For all figures and tables that use statistical methods, confirm that the following items are present in relevant figure legends (or in the Methods section if additional space is needed).

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement (animals, litters, cultures, etc.)
☐	☒ A description of how samples were collected, noting whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ A statement indicating how many times each experiment was replicated
☐	☒ The statistical test(s) used and whether they are one- or two-sided (note: only common tests should be described solely by name; more complex techniques should be described in the Methods section)
☐	☒ A description of any assumptions or corrections, such as an adjustment for multiple comparisons
☐	☒ The test results (e.g. *P* values) given as exact values whenever possible and with confidence intervals noted
☐	☒ A clear description of statistics including central tendency (e.g. median, mean) and variation (e.g. standard deviation, interquartile range)
☐	☒ Clearly defined error bars

See the web collection on statistics for biologists for further resources and guidance.

Software

Policy information about availability of computer code

7. Software

Describe the software used to analyze the data in this study.	Image reconstruction software in the form of MATLAB P-code (available from the authors upon reasonable request).

For manuscripts utilizing custom algorithms or software that are central to the paper but not yet described in the published literature, software must be made available to editors and reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). *Nature Methods* guidance for providing algorithms and software for publication provides further information on this topic.

Materials and reagents

Policy information about availability of materials

8. Materials availability

Indicate whether there are restrictions on availability of unique materials or if these materials are only available for distribution by a for-profit company.	No unique materials were used.

9. Antibodies

Describe the antibodies used and how they were validated for use in the system under study (i.e. assay and species).	No antibodies were used.

10. Eukaryotic cell lines

a. State the source of each eukaryotic cell line used.	No eukaryotic cell lines were used.
b. Describe the method of cell line authentication used.	No eukaryotic cell lines were used.
c. Report whether the cell lines were tested for mycoplasma contamination.	No eukaryotic cell lines were used.
d. If any of the cell lines used are listed in the database of commonly misidentified cell lines maintained by ICLAC, provide a scientific rationale for their use.	No eukaryotic cell lines were used.

Animals and human research participants

Policy information about studies involving animals; when reporting animal research, follow the ARRIVE guidelines

11. Description of research animals

Provide details on animals and/or animal-derived materials used in the study.	No animals were used.

Policy information about studies involving human research participants

12. Description of human research participants

Describe the covariate-relevant population characteristics of the human research participants.	The inclusion criteria for the healthy-volunteer study were as follows: (i) males and females older than 18 years of age; (ii) no known disease and body-mass index (BMI) under 30; (iii) able to undergo MRI (e.g., no metal implants, no claustrophobia). The inclusion criteria for the patient study were as follows: (i) males and females older than 18 years of age; (ii) acute myocardial infarction; (iii) able to undergo MRI (e.g., no metal implants, no claustrophobia). All subjects took part under the approval of the Cedars-Sinai Medical Center Institutional Review Board.

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Date: 6 March 2018

Reporting Summary for MRI studies

Form fields will expand as needed. Please do not leave fields blank.

Experimental design

1. Describe the experimental design.	Technical development pilot study.
2. Specify the number of blocks, trials or experimental units per session and/or subject, and specify the length of each trial or block (if trials are blocked) and interval between trials.	Varies with application; see Methods.
3. Describe how behavioral performance was measured.	Not applicable, as the study did not involve fMRI.

Acquisition

4. Imaging	
a. Specify the type(s) of imaging.	Cardiovascular; parameter mapping and dynamic contrast enhanced imaging.
b. Specify the field strength (in Tesla).	3 Tesla.
c. Provide the essential sequence imaging parameters.	Gradient echo pulse sequence, radial imaging, 270 mm x 270 mm field-of-view, 160 x 160 matrix size, 8 mm slice thickness, cardiac short-axis orientation, 1.6 ms TE, 3.6 ms TR, and 5 degree flip angle, except where otherwise stated.
d. For diffusion MRI, provide full detail on imaging parameters.	Not applicable, as the study did not involve diffusion MRI.
5. State area of acquisition	Chest scans.

Preprocessing

6. Describe the software used for preprocessing.	Not applicable, as no preprocessing was performed.
7. Normalization	
a. If data were normalized/standardized, describe the approach(es).	Not applicable, as no normalization was performed.
b. Describe the template used for normalization/transformation.	Not applicable, as no normalization was performed.
8. Describe your procedure for artifact and structured noise removal.	The low-rank tensor imaging method described in the paper removes artifacts and structured noise that results from undersampling.
9. Define your software and/or method and criteria for volume censoring and state the extent of such censoring.	Not applicable, as there was no volume censoring.

Statistical modeling & inference

10. Define your model type and settings.	Univariate or multivariate, depending on the application; see Methods.

11. Specify the precise effect tested.	Tested differences between reference parameter mapping methods and the proposed method; tested repeatability of parameter mapping and myocardial perfusion measurements; tested noncontrast parameter mapping as a predictor of late gadolinium enhancement.
12. Analysis	
a. Specify whether analysis is whole brain or ROI-based.	Not applicable, as the study did not involve fMRI.
b. If ROI-based, describe how anatomical locations were determined.	Not applicable, as the study did not involve fMRI.
13. State the statistic type for inference. (See Eklund et al. 2016.)	Not applicable, as the study did not involve fMRI.
14. Describe the type of correction and how it is obtained for multiple comparisons.	Not applicable, as the study did not involve fMRI.
15. Connectivity	
a. For functional and/or effective connectivity, report the measures of dependence used and the model details.	Not applicable, as the study did not involve fMRI.
b. For graph analysis, report the dependent variable and functional connectivity measure.	Not applicable, as the study did not involve fMRI.
16. For multivariate modeling and predictive analysis, specify independent variables, features extraction and dimension reduction, model, training and evaluation metrics.	Not applicable, as the study did not involve fMRI.