

Pulsatile lung deformation derived from maximum principal strain of cardiac cine magnetic resonance imaging: assessment of systemic sclerosis related pulmonary fibrosis

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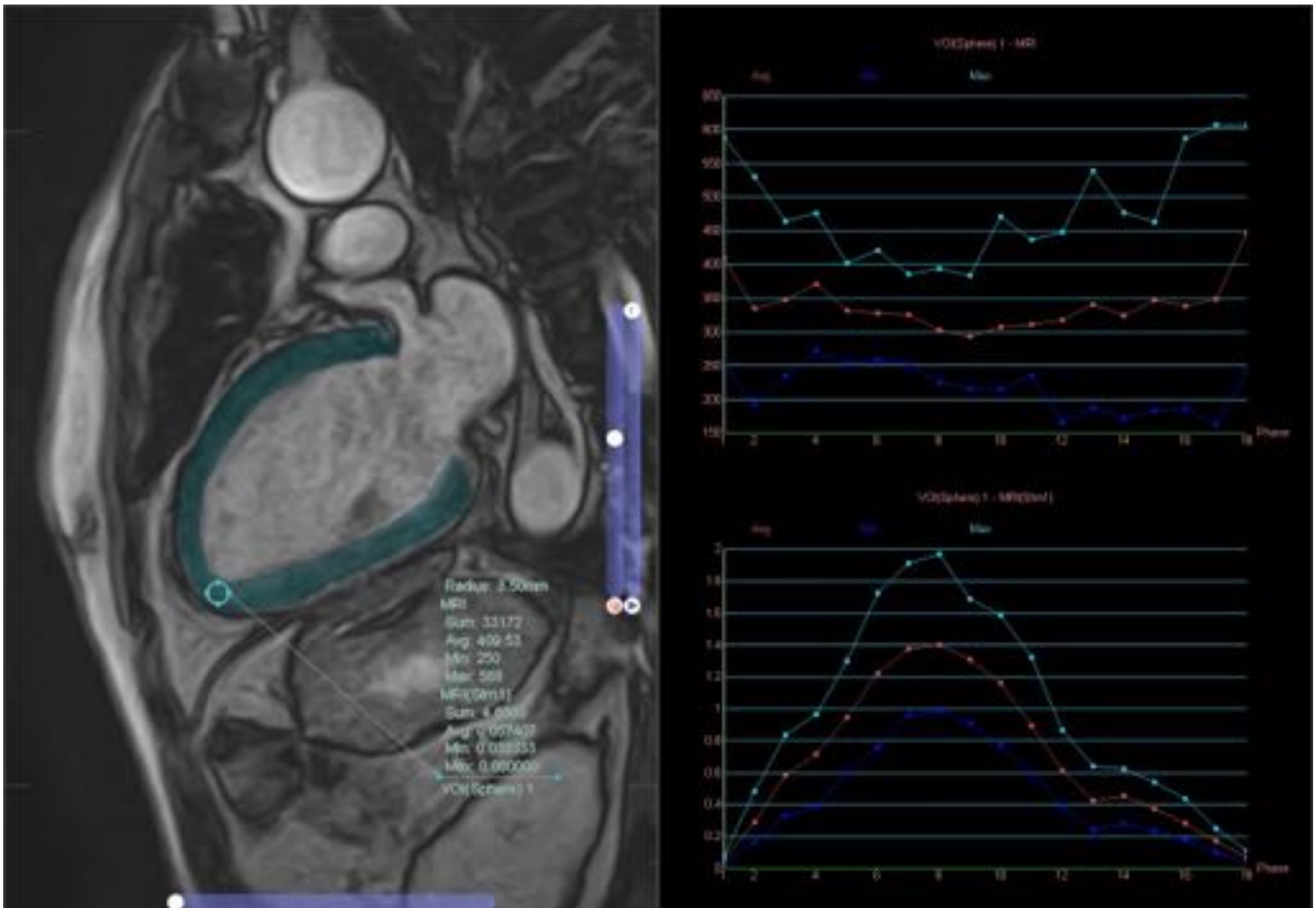
The author has no conflict of interest to disclose with respect to this presentation.

Backgrounds

- ✓ Systemic sclerosis (SSc) is characterized by the progression of fibrosis in the all organs.
- ✓ Pulmonary fibrosis: SSc related interstitial lung disease(SS-ILD)¹⁾ and cardiac involvement are important prognostic factors.

1) Am J Respir Crit Care Med. 2011 Mar 15;183(6):788-824

2D Motion Analysis



M Nagao, et al ,CVIA 2018;2(2):76-84 Ziostation2, Ziosoft, Inc.

Purpose

- ✓ The present study proposes a new imaging technique to analyze pulsatile lung deformation using **2D motion analysis** of cardiac cine MRI (Strain-CMR), and investigates the relation to pulmonary fibrosis and cardiac deterioration in SSc

Patient Characteristics

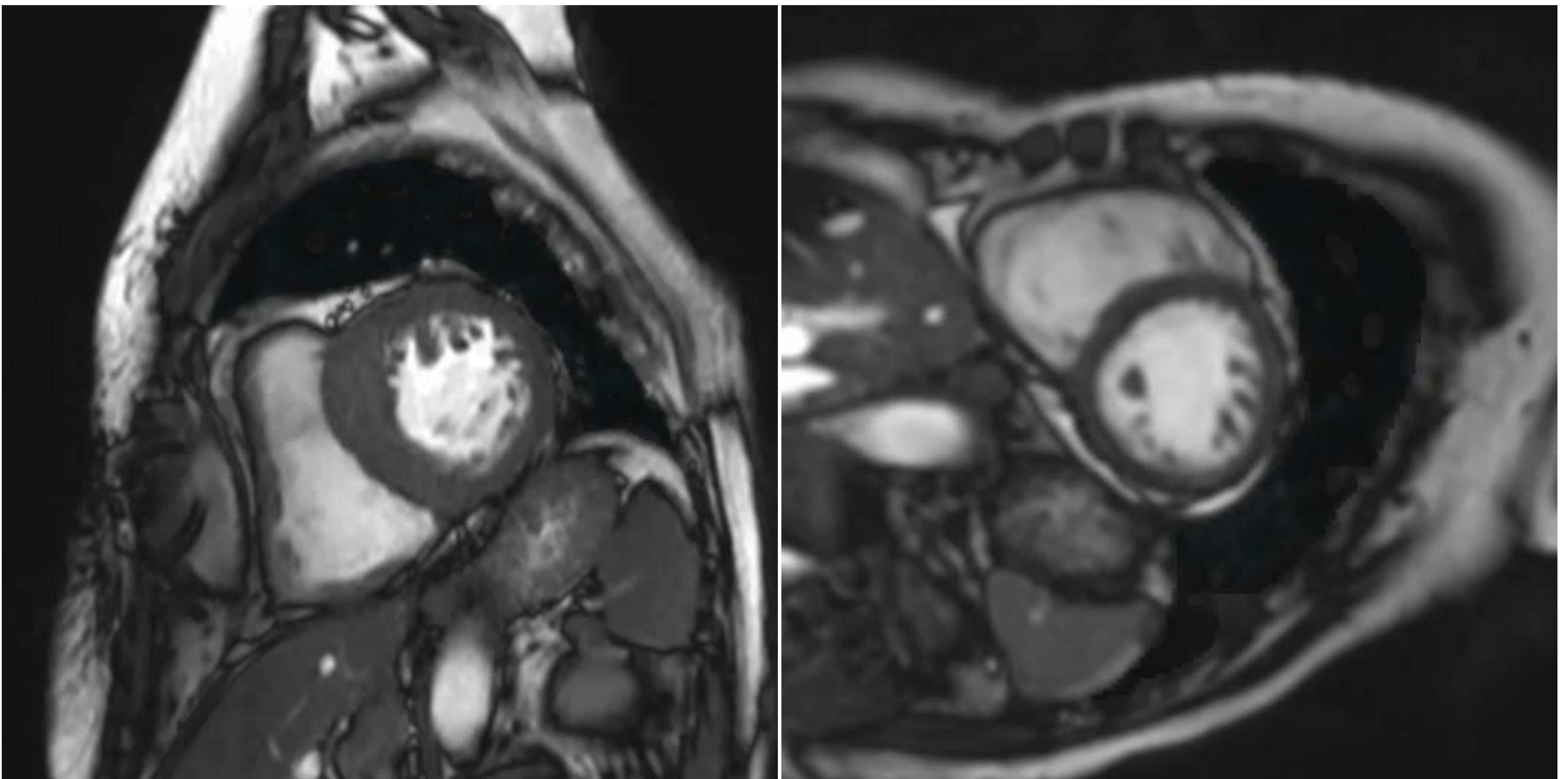
- ✓ *Number : 50 SSc patients*
- ✓ *Mean age : 58.04 years*
- ✓ *Female : 40 (80%)*

	SSc SS-ILD(+)	SSc SS-ILD(-)
Number	23 (46%)	27 (54%)
Age(y)	57.1 (44- 79)	56.4 (24-76)
EF (%)	55.8 (13.5-69)	58.7 (45-69)
KL-6(U/mL)	788.3 (116-1840)	236.6 (165-363)
BNP(pg/mL)	140.1 (15.8-1514.6)	91.5 (6.1-276.2)

The presence of pulmonary fibrosis(SS-ILD) was identified by chest high-resolution CT. Image findings of PF were evaluated based on the findings of inconsistent with usual interstitial pneumonia: UIP according to the guidelines¹).

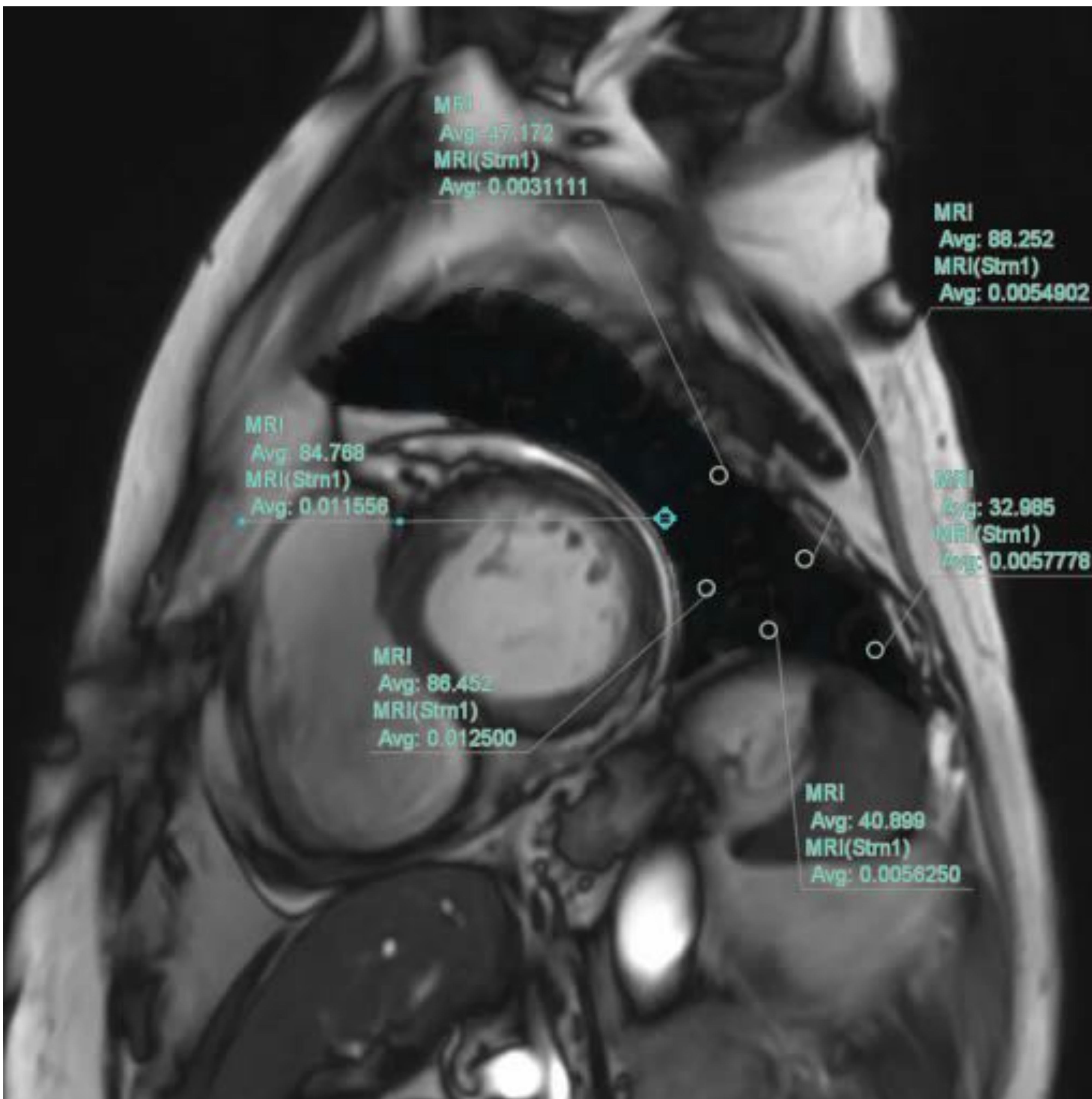
Lung motion using maximum principal strain of cardiac cine MRI

Cardiac cine MR imaging of short-axis left ventricle was performed using a SSFP sequence with 3.0 tesla.



Lung motion using maximum principal strain

The maximum absolute value of the strain during a cardiac cycle was defined as lung strain, and was used as an estimate of pulsatile lung deformation.

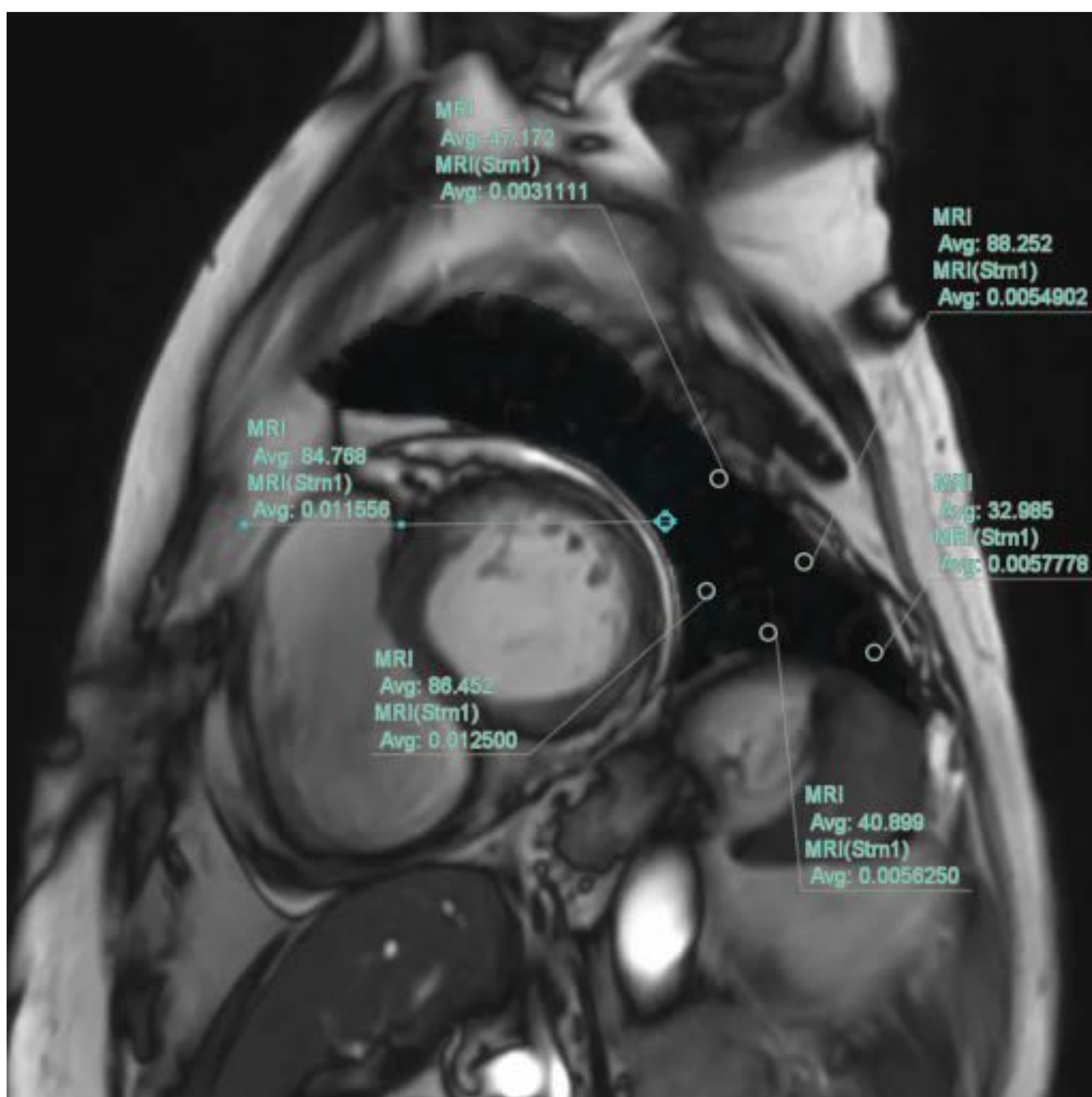


No.1 and 2:
Heart-adjacent segment
No. 3, 4, 5 and 6:
Peripheral segment

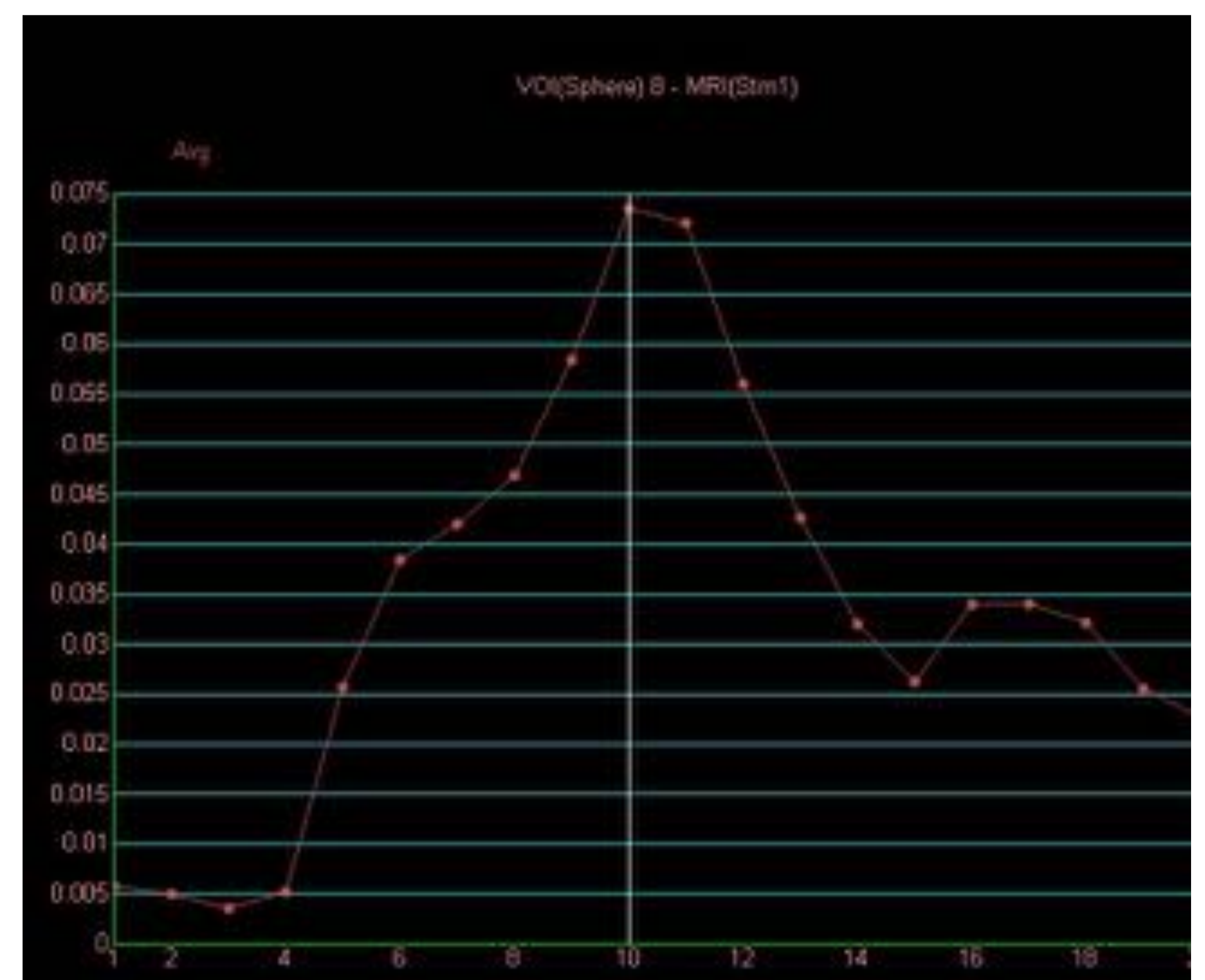
1. Cine image is closest to the left lung and the mostly movement by heart beat were selected.
2. Peripheral zone of the lower lung with a depth of 1 cm from the pleura were set as a region of interest, and the strain in the radial direction to the center of the left lung was calculated using Strain-CMR.

Lung motion using maximum principal strain

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The maximum absolute value of the strain



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Evaluation

- *two types of lung strains*

- ✓ **Heart-adjacent segment** : segments of No.1 and 2

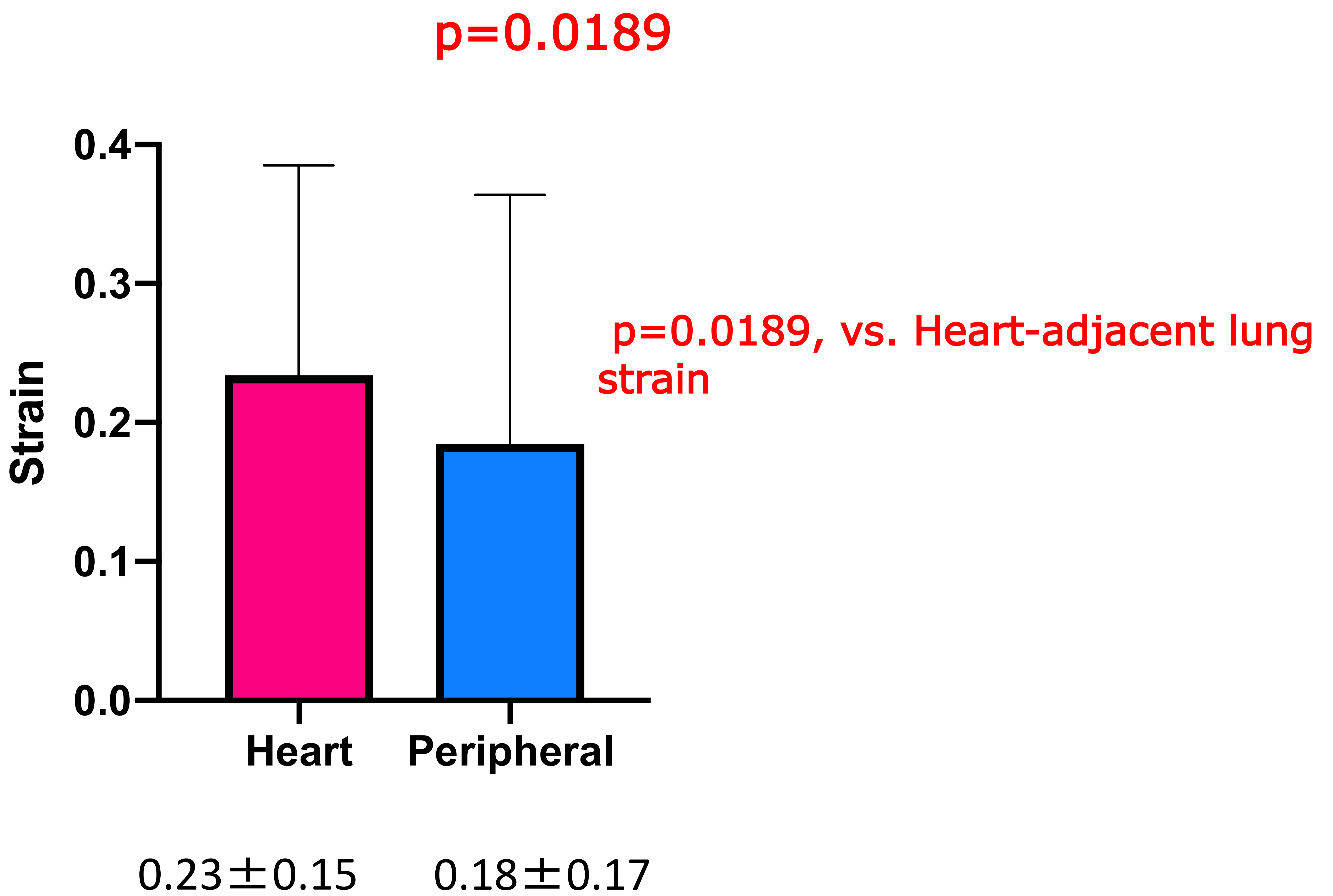
- ✓ **Peripheral segment** : segments of No. 3, 4, 5, and 6

1. Comparison of heart-adjacent and peripheral lung strain, unpaired t-test
2. Comparison of lung strain between patients with and without SS-ILD, Mann-Whitney U-test
3. Comparison of lung strain between patients with KL-6 <500 U/ mL and >500 U/mL, Mann-Whitney U-test
4. Correlation between lung strain and EF, Pearson correlation coefficient

Result-1

Heart-adjacent vs. Peripheral lung strain

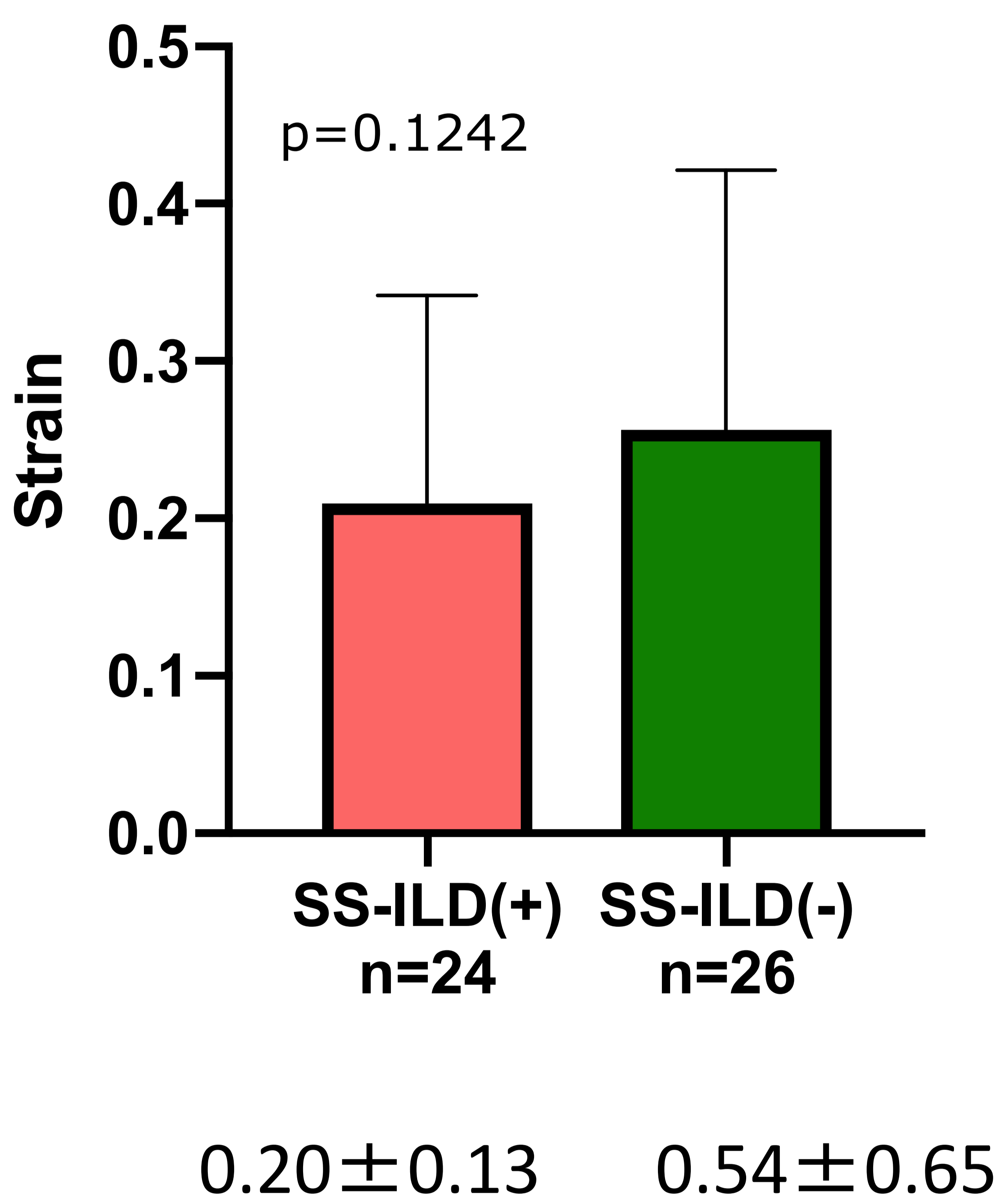
✓Two types of lung strain can be calculated for all patients.



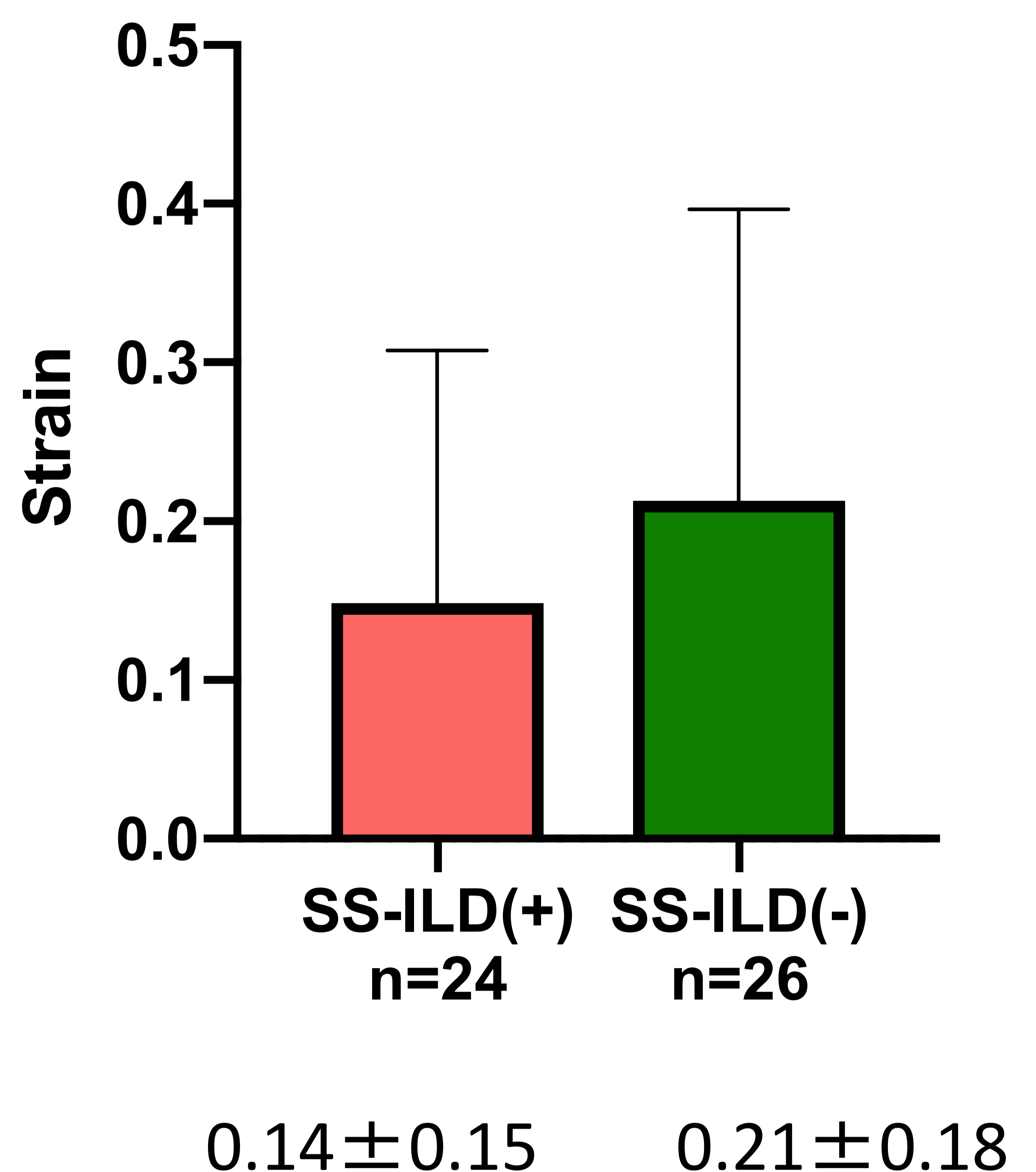
Result-2

Comparison of lung strain between patients with and without SS-ILD

Heart-adjacent segment



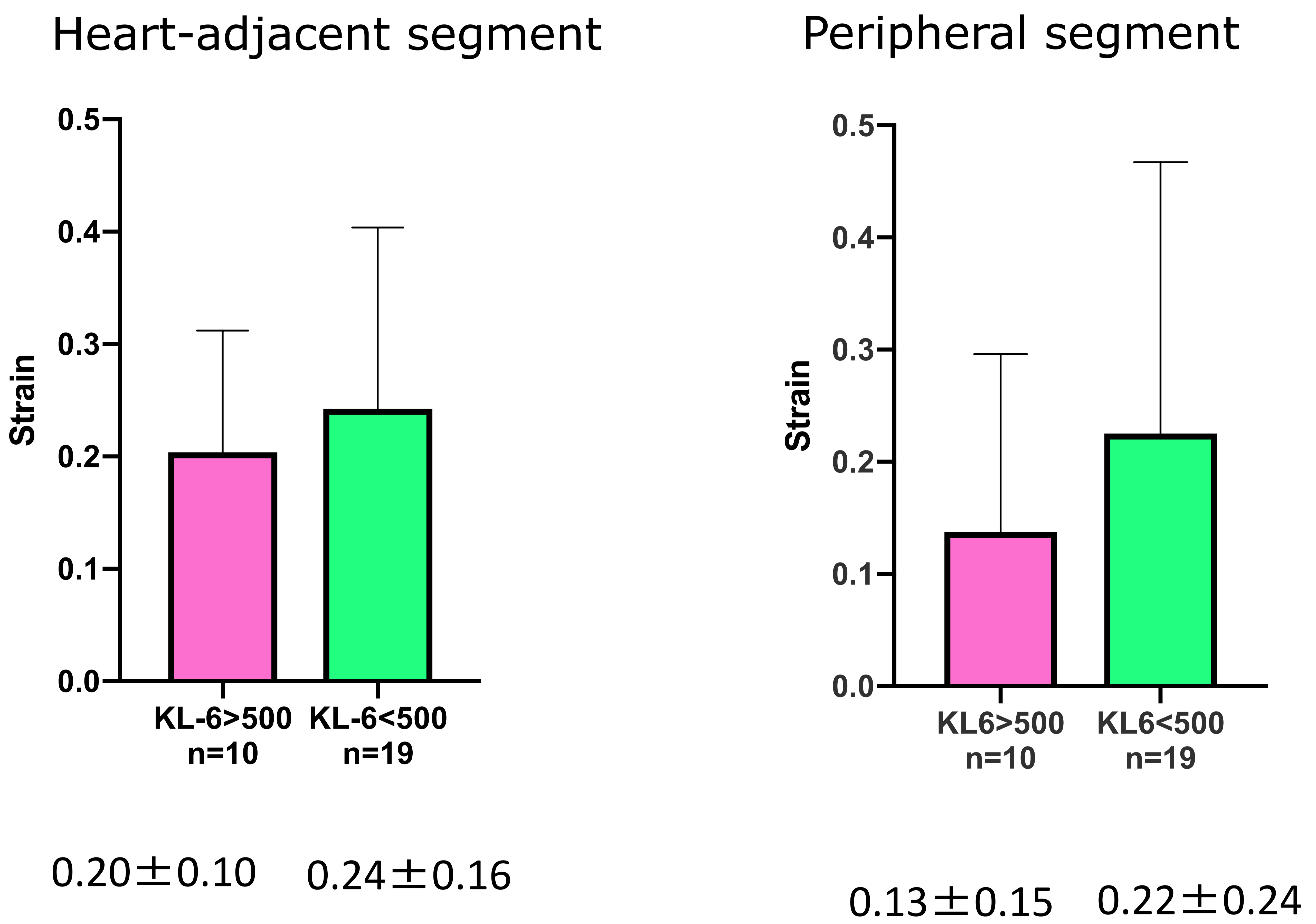
Peripheral segment



p=0.0064, vs Peripheral segment lung strain

Result-3

Comparison of lung strain between patients with KL-6 <500 U/ mL and >500 U/mL

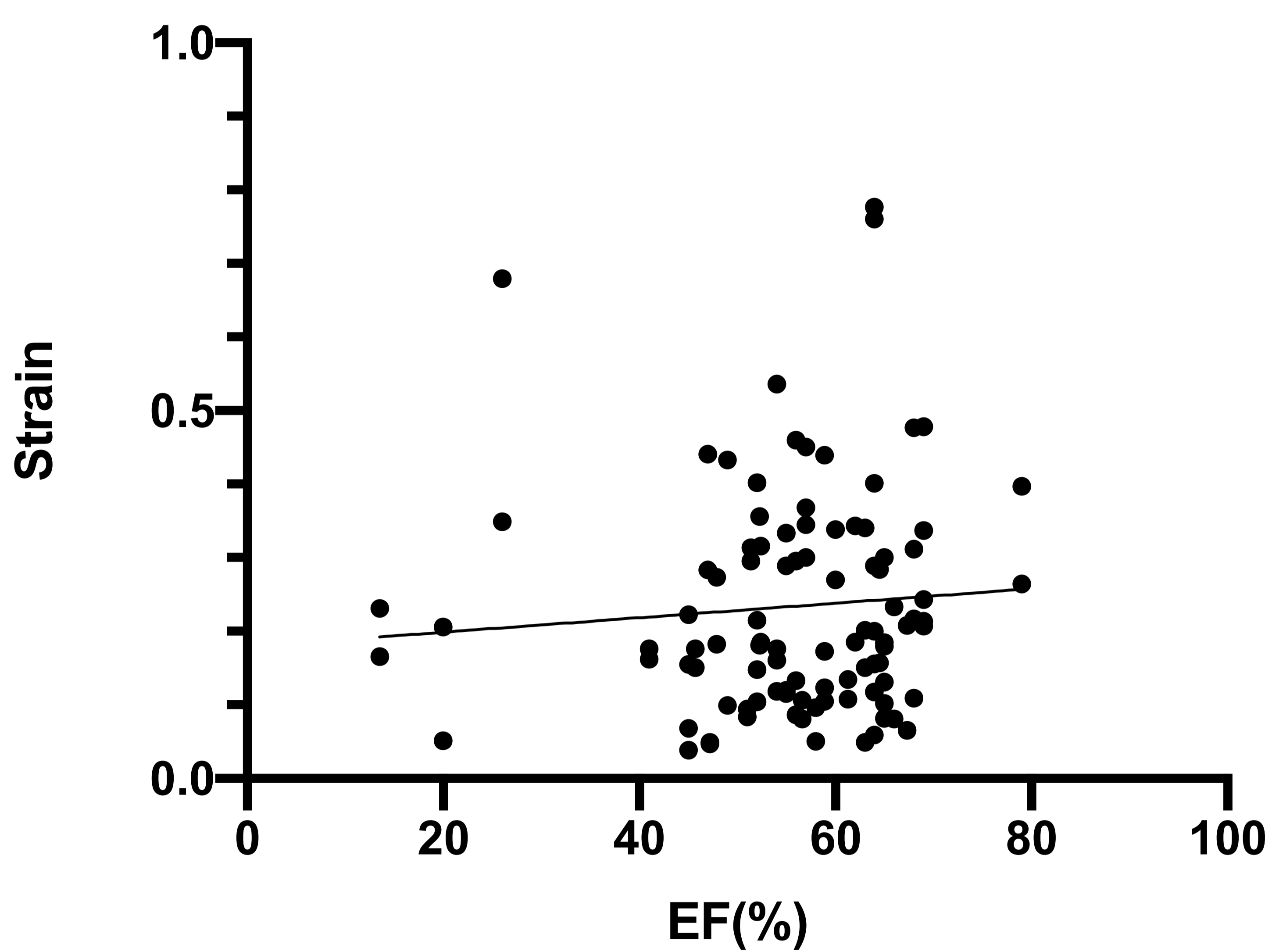


p=0.0412, vs Peripheral segment lung strain

Result-4

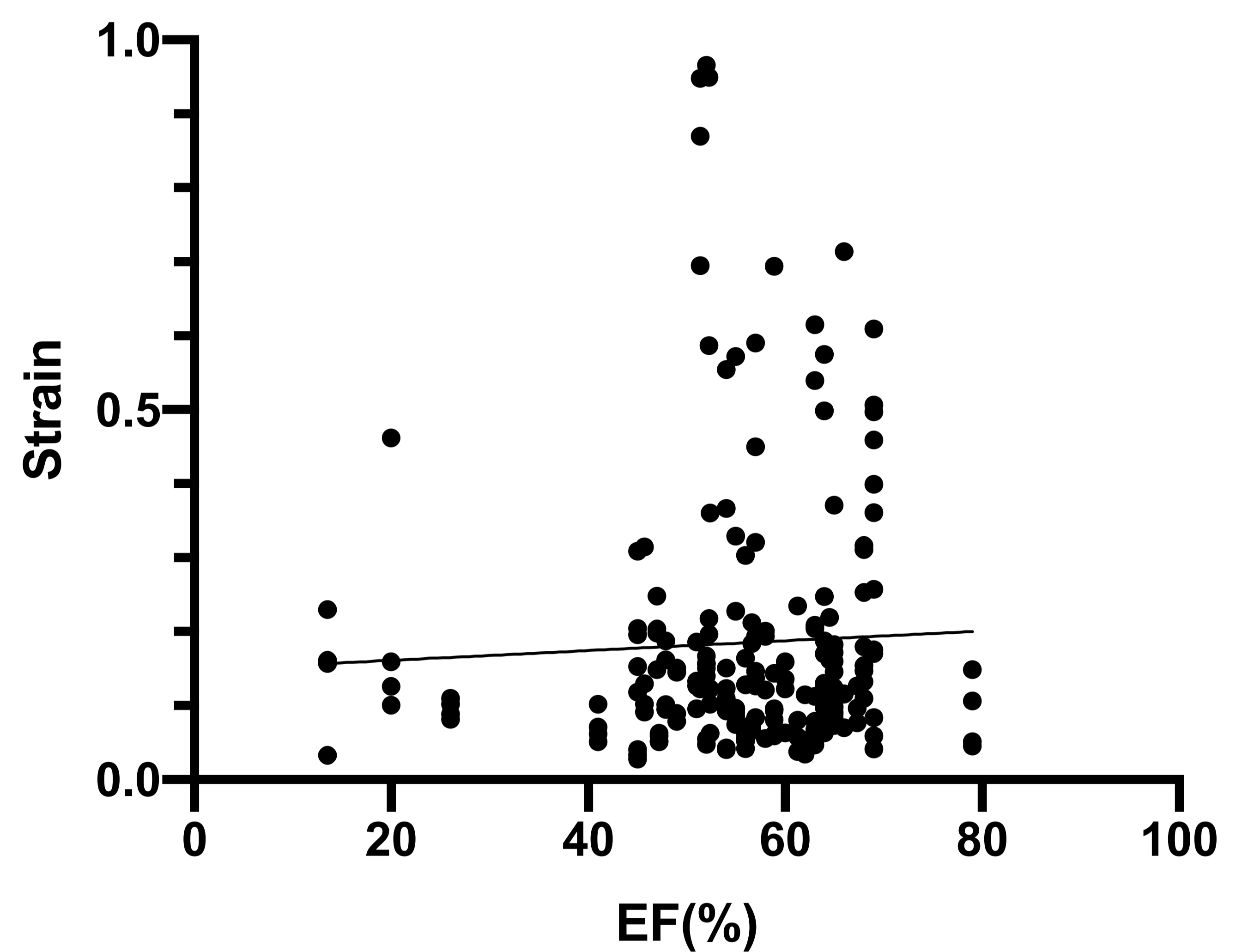
Correlation between lung strain and EF

Heart-adjacent segment



$r=0.0062, p=0.4336$

Peripheral segment



$r=0.002, p=0.5289$

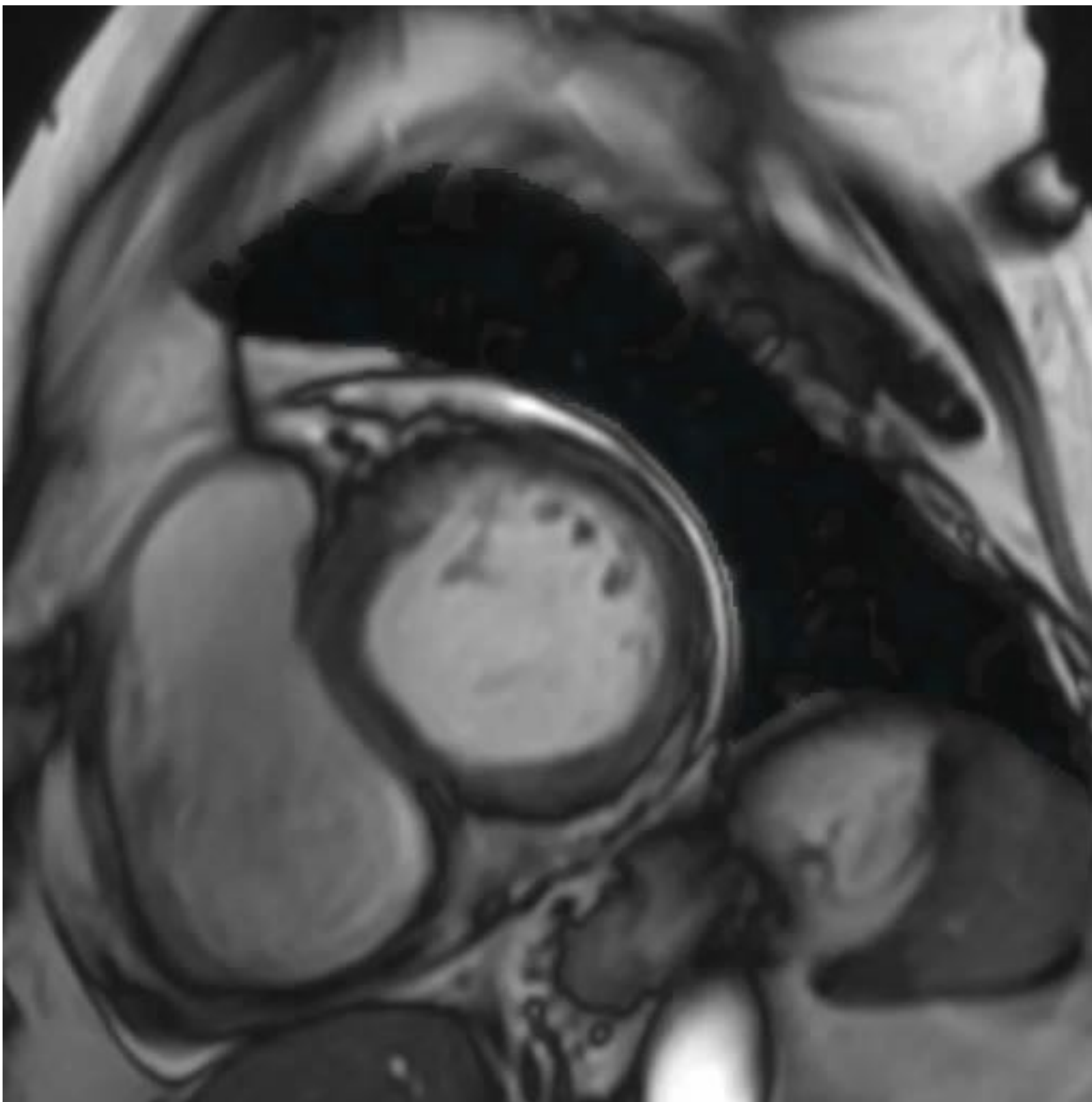
No correlation between strain and EF was observed.

No significant correlation between lung strain and EF was observed.

60's Female with SS-ILD KL-6 **1792** U/mL, BNP 45 pg /mL, EF 45%
Lung Strain: ①0.038 ②0.067 ③0.033 ④0.027 ⑤0.040 ⑥ 0.118

Lung strain, 5.0%
Heart-adjacent lung strain, 5.1%
Peripheral lung strain, 4.9%

*Mean
Heart 0.23
Peripheral 0.18



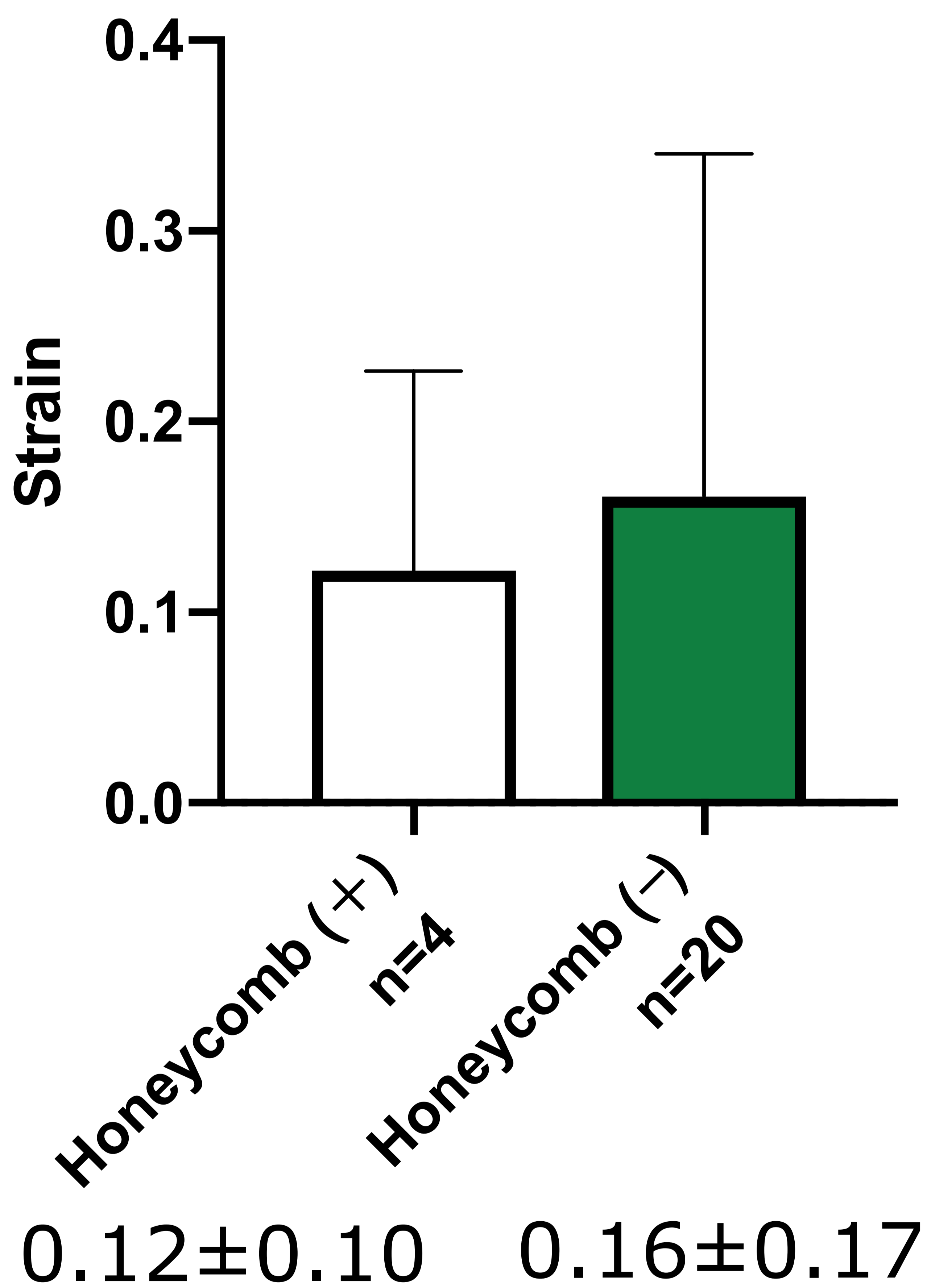
Discussion

- ✓ We have developed a new method for evaluating fibrosis of the lung using **2D motion analysis** of heart cine MRI.
- ✓ Cardiac cine MRI adding lung strain enables non-invasively both evaluations of cardiac function and pulmonary fibrosis.
- ✓ Lung fibrosis is seen **in the peripheral lower lung**. Therefore, significant results were obtained from peripheral strain of the lower lung.
- ✓ Lung strain is independent from cardiac movement.

Discussion

The presence of honeycomb lung decreases lung strain?

Peripheral segment



✓ It seems to be a correlation between lung strain and honeycomb lung, but this number is small and future study is necessary.

Conclusion

- ✓ Development of pulmonary fibrosis in SSc associates with decreasing pulsatile lung deformation.
- ✓ **Strain-CMR** derived **2D motion analysis** is a new functional technique for assessment of pulmonary fibrosis.

• *thank you*