

Automated Segmentation and Quantitation of PET/CT Images Using ¹²⁴I-p5+14 (AT-01) in Patients with AL and ATTR Amyloidosis

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INTRODUCTION

- System amyloidoses are a severe, multi-organ, heterogeneous disease group which are difficult to assess as no radiotracers detect and track the disease.
- We developed a PET peptide radiotracer to detect diverse forms of systemic amyloid ¹²⁴I-p5+14 (AT-01), which was evaluated in a Phase 1/2 study (Figure 1)
- Here, we quantify AT-01 PET/CT images using a fully automated recently developed 3D software (AIQ Solutions' TRAQinform IQ) and compare this method with our current standard using 2D regions of interest manually placed by an experienced reader

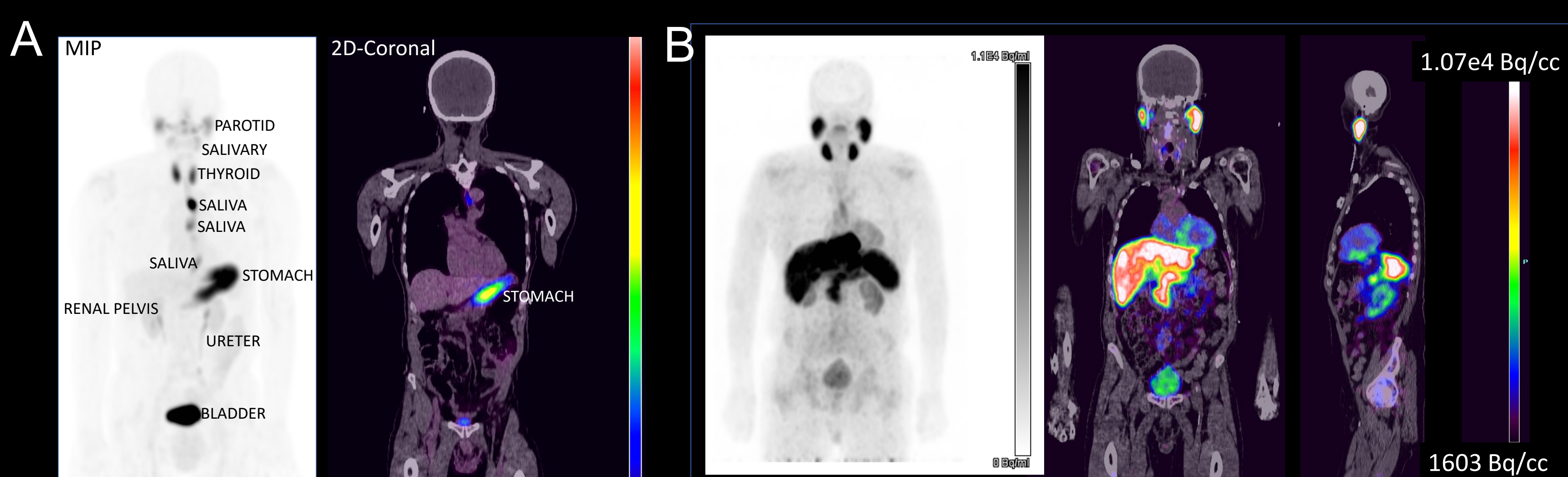
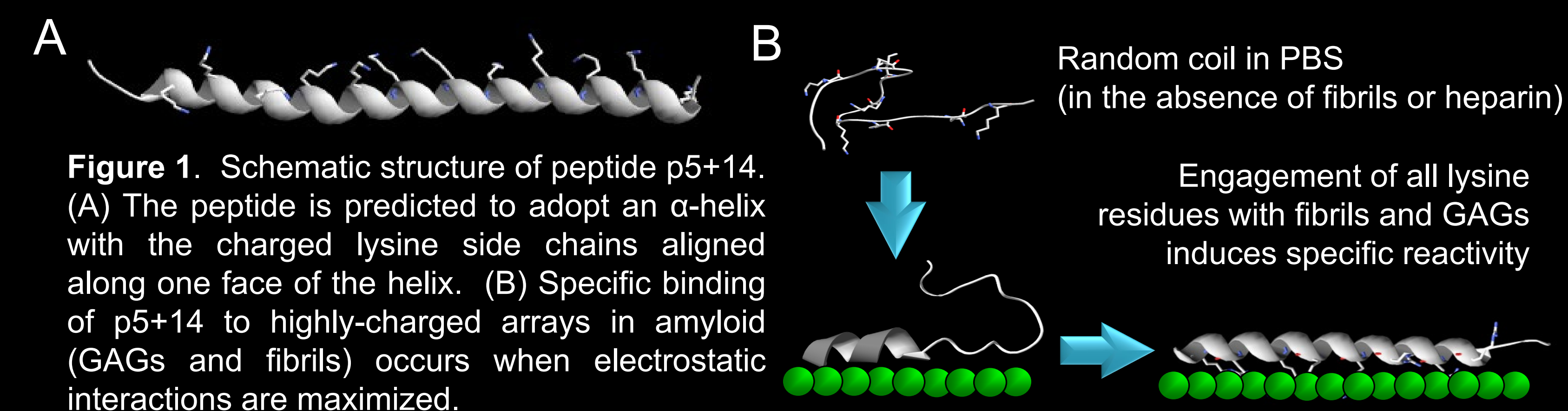
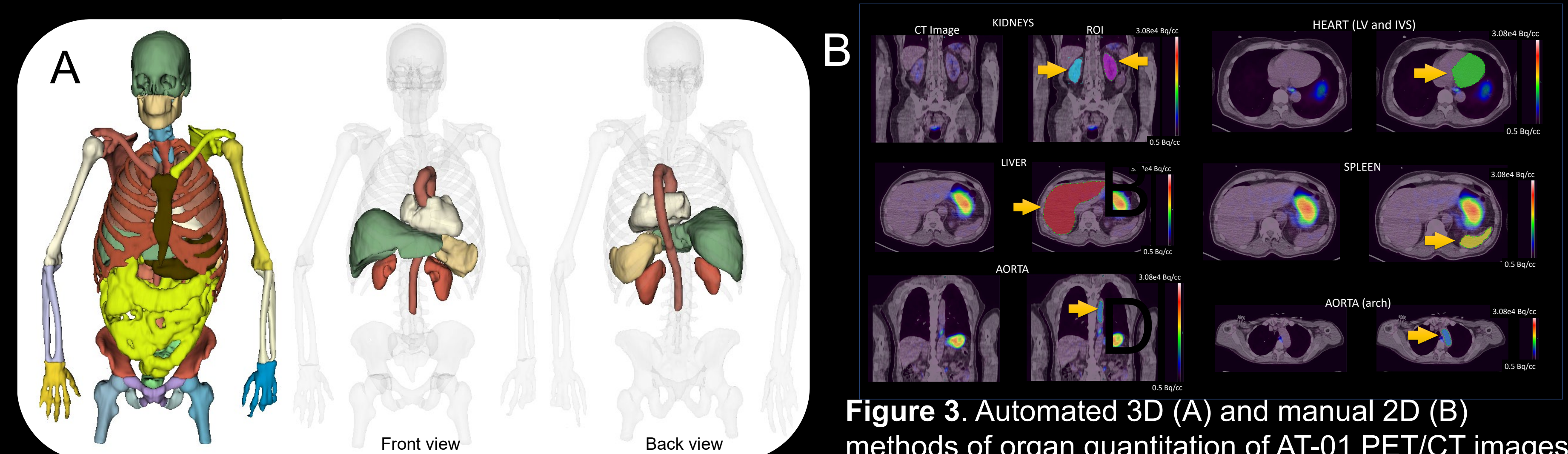


Figure 2. Biodistribution of AT-01 in a representative healthy subject (A) and patient with systemic AL amyloidosis (B). Maximum intensity projection and coronal views in (A) show physiologic uptake was observed in the parotid, salivary and thyroid glands, as well as saliva, stomach lumen, urine in ureters, and bladder. No myocardial uptake was observed.

MATERIALS AND METHODS

- Subjects >18 years with diagnosis of transthyretin (ATTR, N=20) or monoclonal immunoglobulin light chains (AL, N=23) amyloidosis were included
- PET/CT images were acquired 5-6 hours post injection of <2 mg of AT-01 (≤ 2 mCi I-124) using a Biograph PET/CT scanner.
- Fully automated 3D SUV_{mean} quantification:
 - The entire liver, spleen, kidneys, heart, and aorta were automatically segmented on the CT (Figure 3A) using a 3D U-net convolutional neural network pre-trained using 533 CT images and externally validated in 170 CT images
 - Automated CT contours were applied to the AT-01 PET data for quantitation of mean standardized uptake value (SUV_{mean}), normalized by mean aorta lumen radioactivity, resulting in automated 3D SUV_{mean} outputs
- Fully manual 2D SUV_{mean} quantification: a single representative slice of each organ was chosen manually and normalized using the thoracic aorta lumen as the reference, resulting in 2D SUV_{mean} outputs (Figure 3B)
- Significant correlation between automated 3D SUV_{mean} and manual 2D SUV_{mean} values was determined using Pearson's correlation analysis.



RESULTS

- External validation of automated segmentation showed high dice similarity coefficients for all organs in 170 CT images (Table 1).
- Excellent positive correlations between automated 3D SUV_{mean} and manual 2D SUV_{mean} were found for all major abdominothoracic organs (Figs 4 and 5).
- Single slice quantitation values were generally higher than the whole organ quantitation.
- When combining AL and ATTR patient data and assessing the heart, the correlation was highly significant between the two methods (Pearson $r = 0.9249$, $p < 0.0001$).

Table 1. Performance of automated organ segmentation. Median [interquartile range] is shown.

Organ	Dice Similarity Coefficient
Liver	0.95 [0.94, 0.96]
Spleen	0.94 [0.92, 0.95]
Kidneys	0.93 [0.91, 0.94]
Heart	0.92 [0.91, 0.94]
Aorta	0.92 [0.90, 0.93]

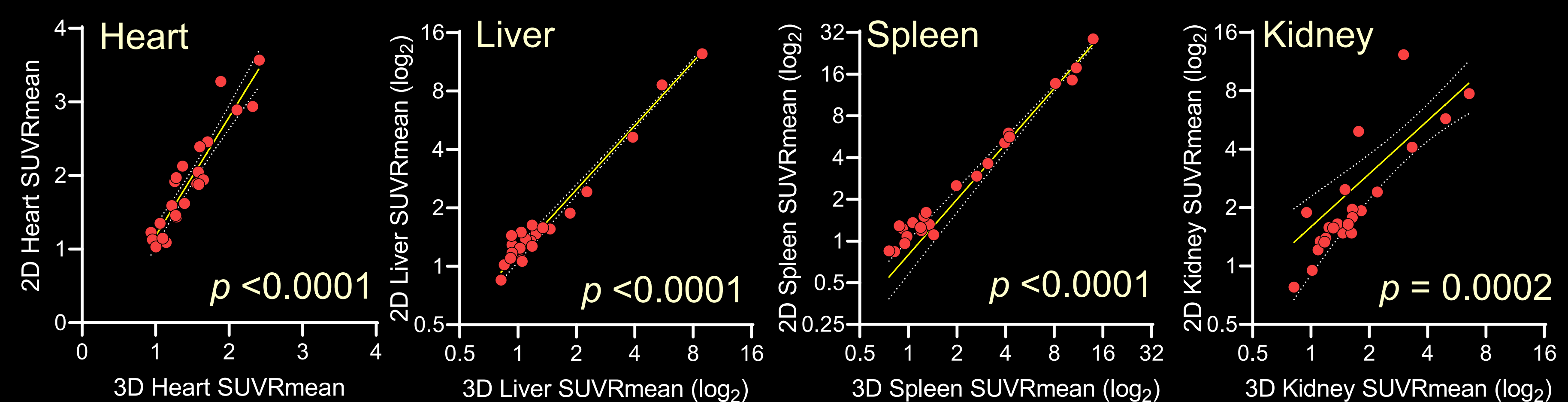


Figure 4. Correlation of automated 3D and manual 2D segmentation of abdominothoracic organs in patients with AL amyloidosis. Pearson correlation significance value and linear regression with 90% confidence bands are shown.

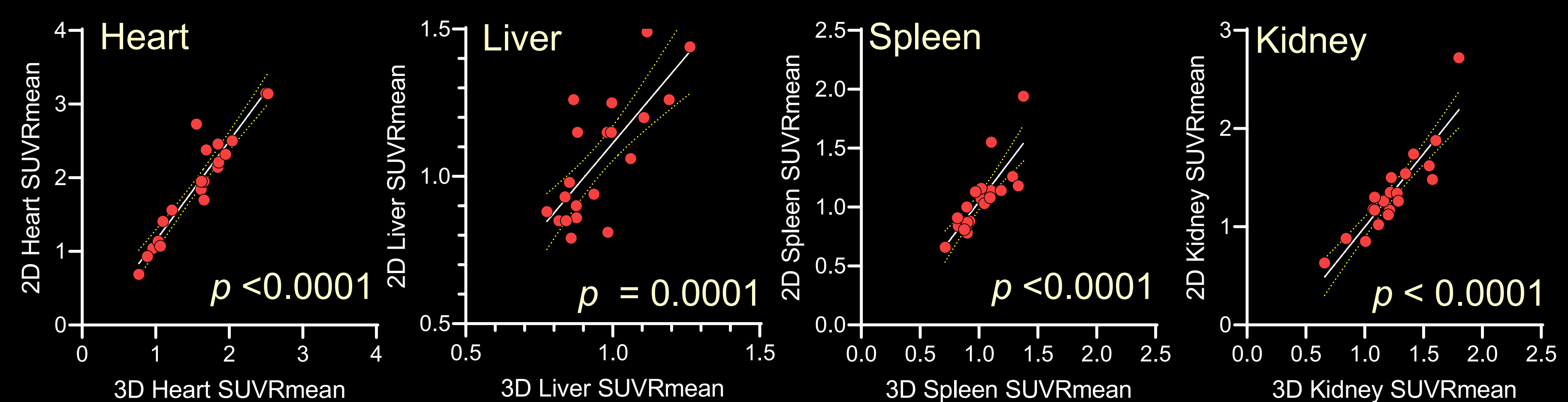


Figure 5. Correlation of automated 3D and manual 2D segmentation of abdominothoracic organs in patients with ATTR amyloidosis. Pearson correlation significance value and linear regression with 90% confidence bands are shown.

DISCUSSION

Given the novelty of the AT-01 radiotracer and the heterogeneous presentation of disease in this patient population, this automated approach to image analysis of AT-01 PET/CT data would be an invaluable tool for novice readers and those seeking to quantify amyloid burden longitudinally without introducing reader bias. *This approach will significantly impact the ease of use and improve accuracy of image interpretation that will ultimately benefit clinical management of patients with amyloidosis.*