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INTRODUCTION

Adaptive radiotherapy (ART) and personalized ultra fractionated stereotactic adaptive radiotherapy (PULSAR) require longitudinal anatomical modeling, deformable image registration (DIR), and dose recalculation and accumulation. While these capabilities are well established in human radiotherapy, they remain largely unavailable in veterinary practice. This work presents a quantitative translational platform designed to support ART and PULSAR workflows in veterinary radiotherapy while maintaining compatibility with clinical treatment planning systems.

METHOD

We developed PETS CARE AdaPT, an integrated platform that standardizes veterinary imaging and treatment data and enables longitudinal anatomical and dosimetric analysis.

- Imaging and treatment plans were archived using DICOM compliant formats with standardized structure nomenclature.
- Template guided AI segmentation adapted from human models were used to generate organ at risk and target contours.
- For longitudinal assessment, region of interest–constrained DIR (RC DIR) was implemented to improve registration stability in the presence of tumor regression and large anatomical deformation.
- Delivered dose was recalculated on longitudinal imaging using a Monte Carlo (MC)–based dose engine, and dose deformation was applied to accumulate dose.

The workflow was evaluated on nine veterinary patients, including three thoracic, two pelvic, and four head and neck cases.

RESULTS

- An inhouse repository with DICOM compliant format for images, RT structures, RT plans, and RT doses (figure 1).
- AI segmentation performed well for thoracic cases in prone position (figure 2)
- Nonstandard positions can be challenging for AI models trained based on human data, e.g., when the patient is lying side way (figure 3).

DB Browser for SQLite				
PatientSex	PatientPosition	Rows	Columns	NumberOfSlices
Filter	Filter	Filter	Filter	Filter
O	HFP	410	410	107
O	HFP	410	410	107
O	HFP	410	410	107
O	HFP	410	410	107
O	HFP	410	410	88
M	FFP	410	410	161
M	FFP	410	410	88
O	HFP	410	410	161
O	HFP	410	410	107
F	HFP	410	410	138
F	HFP	410	410	107
F	HFP	410	410	161
M	HFP	410	410	322
M	HFP	410	410	322
O	HFP	410	410	322
O	HFP	410	410	322
M	FFP	410	410	161
M	HFP	410	410	161
M	HFDL	410	410	161
F	FFP	410	410	322

Figure 1. Example of DICOM image attributes in our database.

RESULTS (CONTINUED)

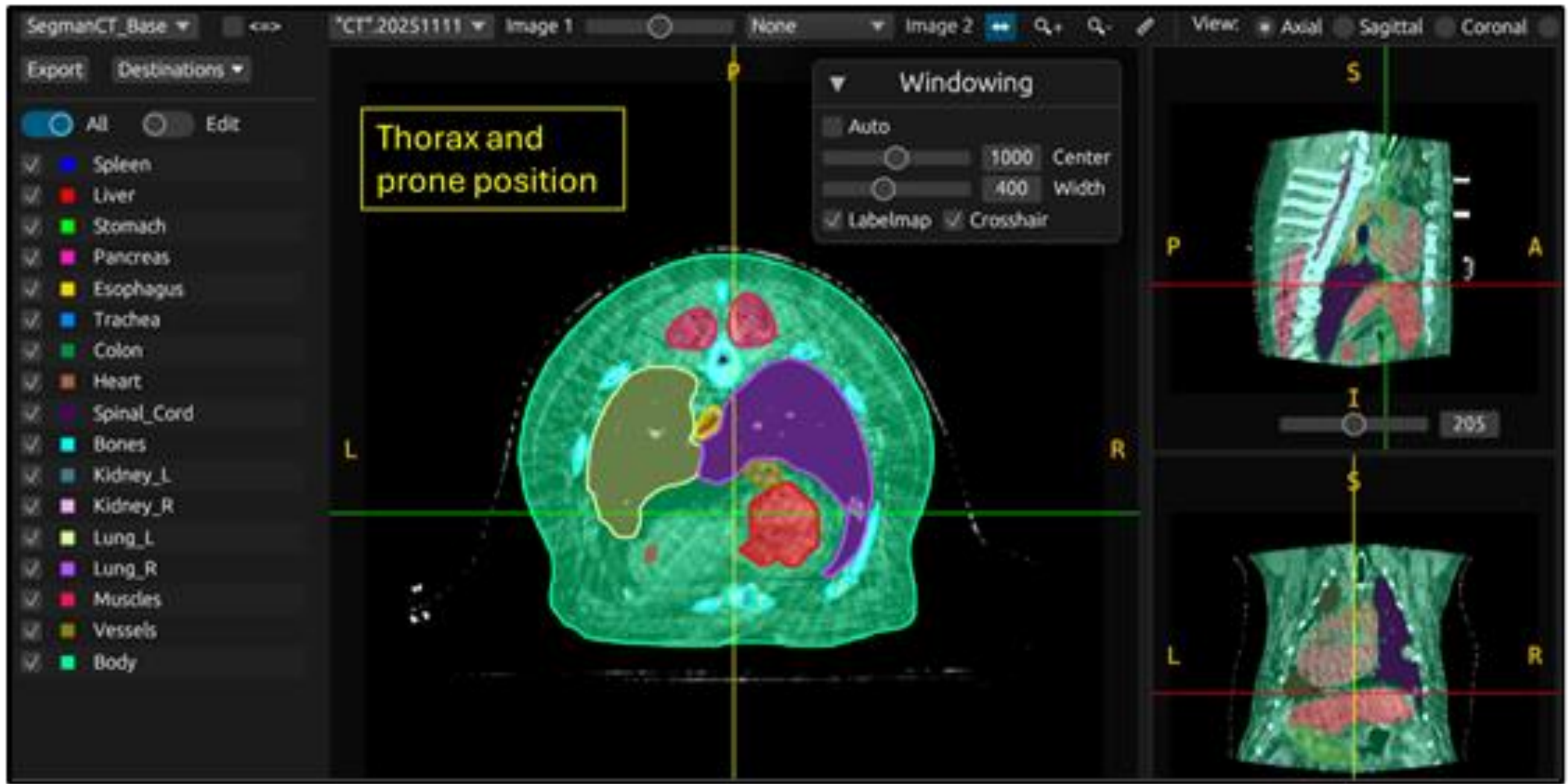


Figure 2 AI segmentation performed well for a thoracic case in prone position.

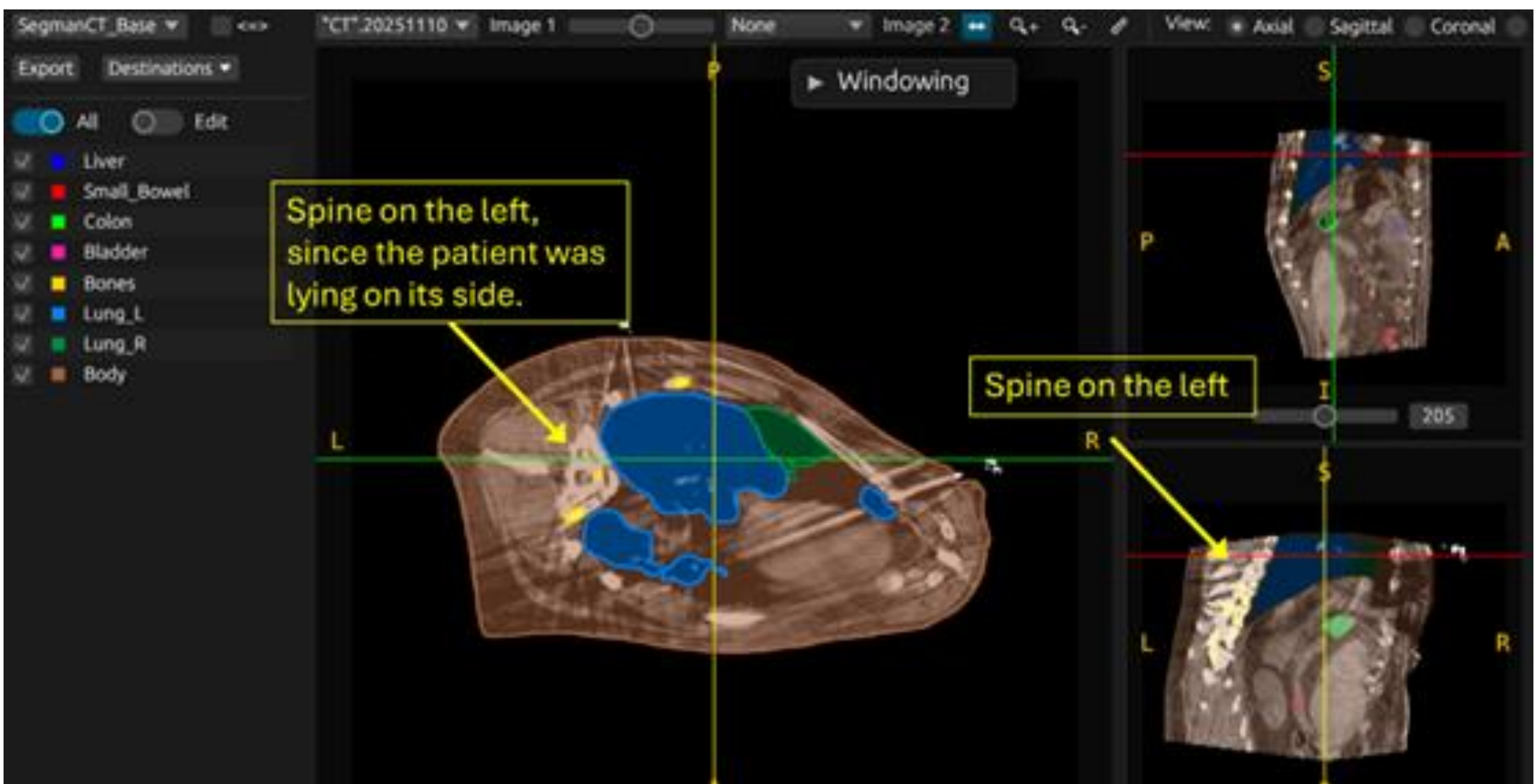


Figure 3 Segmentation for thorax with lateral recumbency (spine on the left) is challenging, given the AI model trained on the human data.

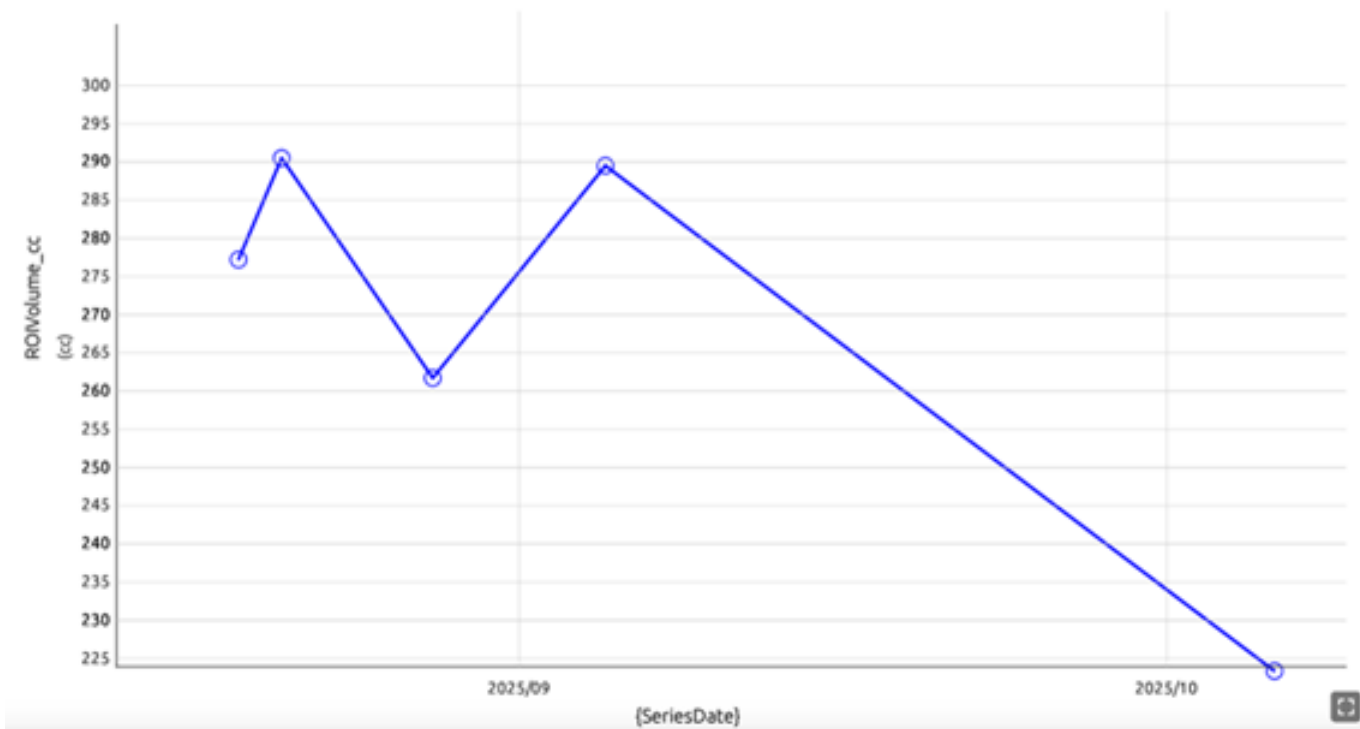


Figure 4 Left: Tumor tracking through RC-DIR based propagation for tumor contouring on images taken on different days. Right: tumor volume over time (y-axis: volume with unit of CC; x-axis: date of imaging).

CONCLUSION

PETS CARE AdaPT provides the first integrated platform for quantitative segmentation, deformable tumor tracking, MC dose recalculation, and deformable dose accumulation in veterinary radiotherapy. The platform establishes a robust dosimetric foundation for ART and PULSAR workflows in companion animals and enables standardized translational studies aligned with modern clinical radiotherapy practice.