

Sensitivity of Dosimetry Calculations to Tumor Segmentation Methods on SPECT/CT Images for Patients Undergoing ¹⁷⁷Lu-PSMA-617 RPT

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Question

What are the volumetric, geometric, and dosimetric differences caused by variations in tumor contouring methods for voxel-level radiopharmaceutical therapy (RPT) dosimetry?

Introduction

- SNMMI Dosimetry Challenge reports **variability in lesion volume** and **resulting mean dose**
 - Reported variability of **176% in volume** **57.7% in mean dose**
 - Underscoring the **need for tumor segmentation standardization**
- The **PK fitting affects the Time Integrated Activity** which **affects the dose**
- Different contours can result in **differences in perceived activity** which **affect the PK fitting**

Methods

Segmentation

- Quantitative SPECT/CT acquired at 4 hours (TP1), 24 hours (TP2), and 96 hours (TP3) post ¹⁷⁷Lu-PSMA-617 administration
- Tumors segmented on 14 patients using a gradient-based method (PE+) and a Standard Uptake Value (SUV) threshold of SUV > 2.5 method at all timepoints (TPs)

Dosimetry

- Voxel-based dosimetry was performed in Torch (Voximetry, Inc.) with Monte Carlo dose calculation

Data analysis

- Measured tumor volume and D_{mean}
- Evaluated contour agreement vs. physician contours as baseline using Dice Similarity Coefficient (DSC)

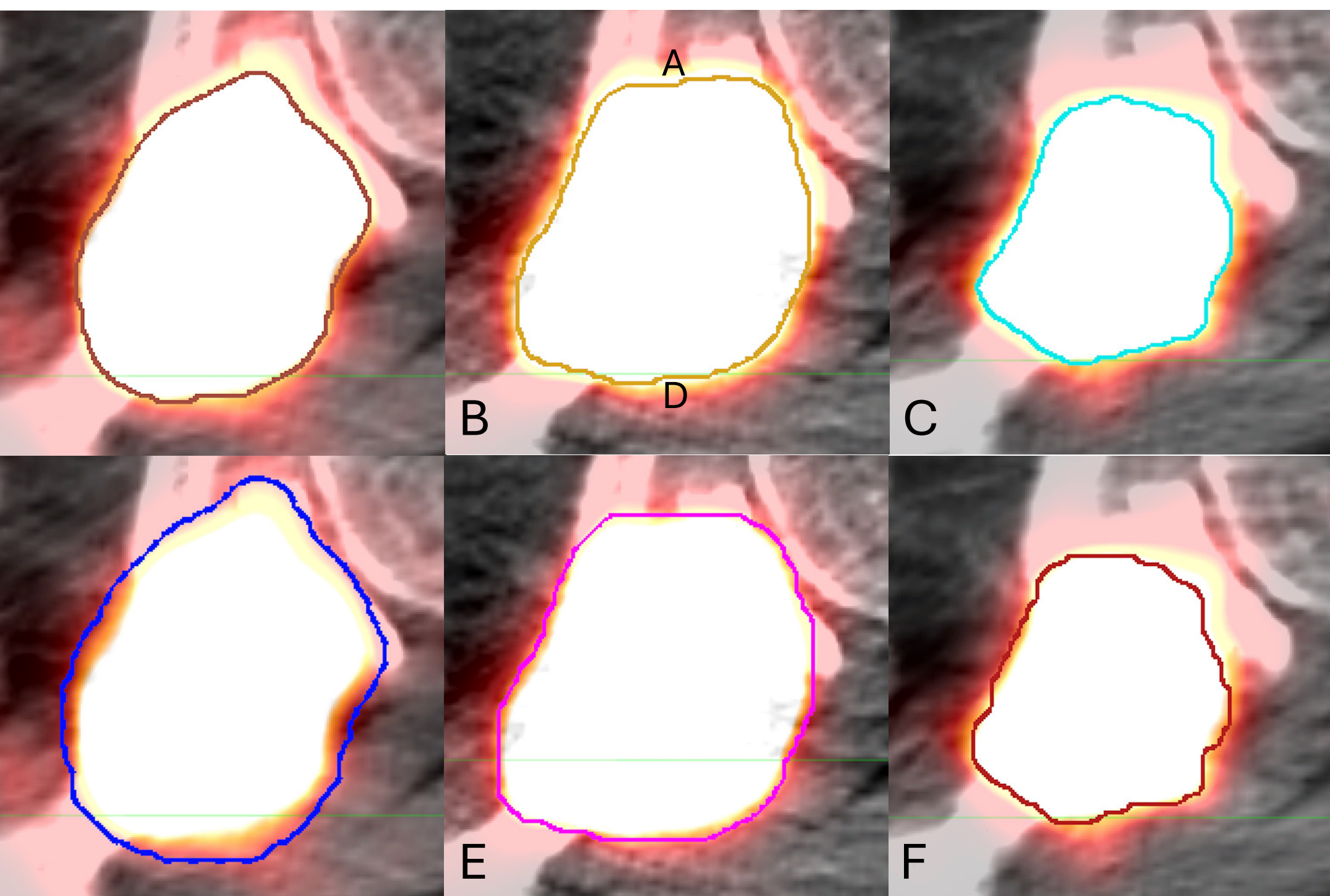


Figure 1: Example contour methods A) SUV TP1, B) SUV TP2, C) SUV TP3, D) PE+ TP1, E) PE+ TP2, F) PE+ TP3

Volumetric and Geometric Differences

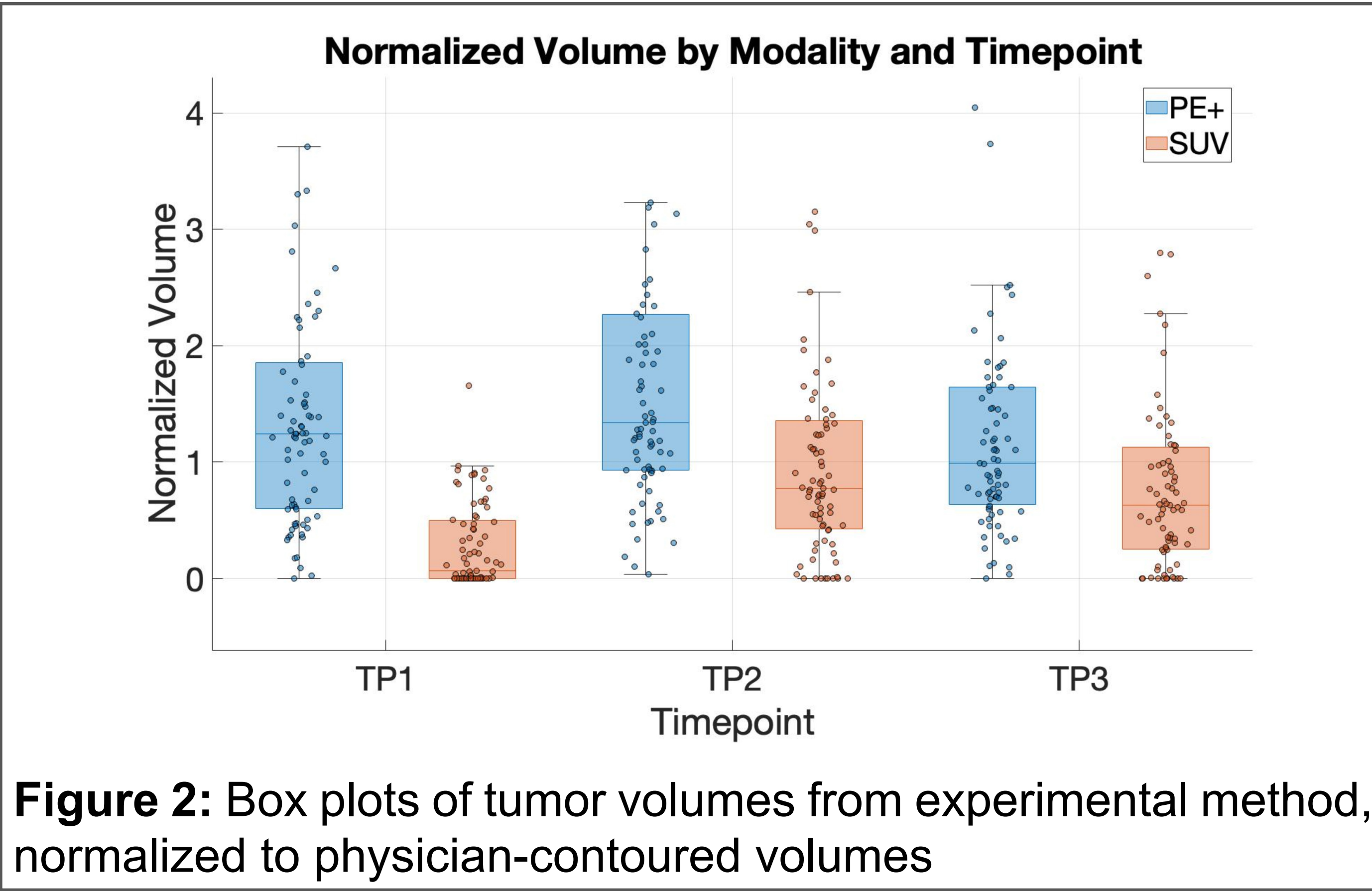


Figure 2: Box plots of tumor volumes from experimental method, normalized to physician-contoured volumes

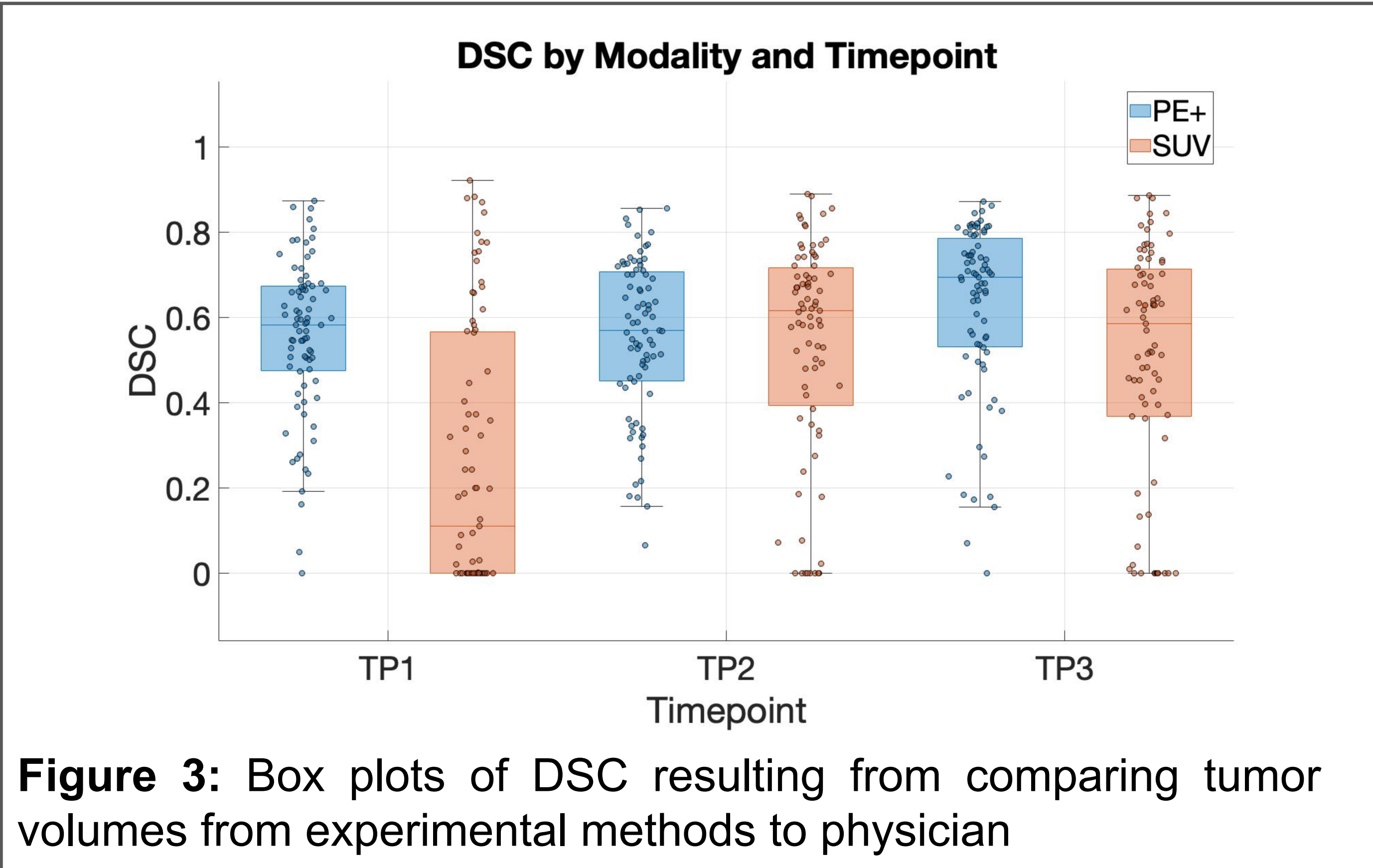


Figure 3: Box plots of DSC resulting from comparing tumor volumes from experimental methods to physician

	Mean Values for Different Metrics					
	PE+ TP1	PE+ TP2	PE+ TP3	SUV TP1	SUV TP2	SUV TP3
Volume	1.68	1.93	1.49	0.32	1.07	0.81
DSC	0.54	0.58	0.63	0.27	0.54	0.48
D _{mean}	0.89	0.90	1.03	0.83	0.94	1.28

Table 1: Mean of Normalized Volume, DSC and Normalized D_{mean} for the contouring methods for the PE+ and SUV method at all three TPs

Dosimetric Differences

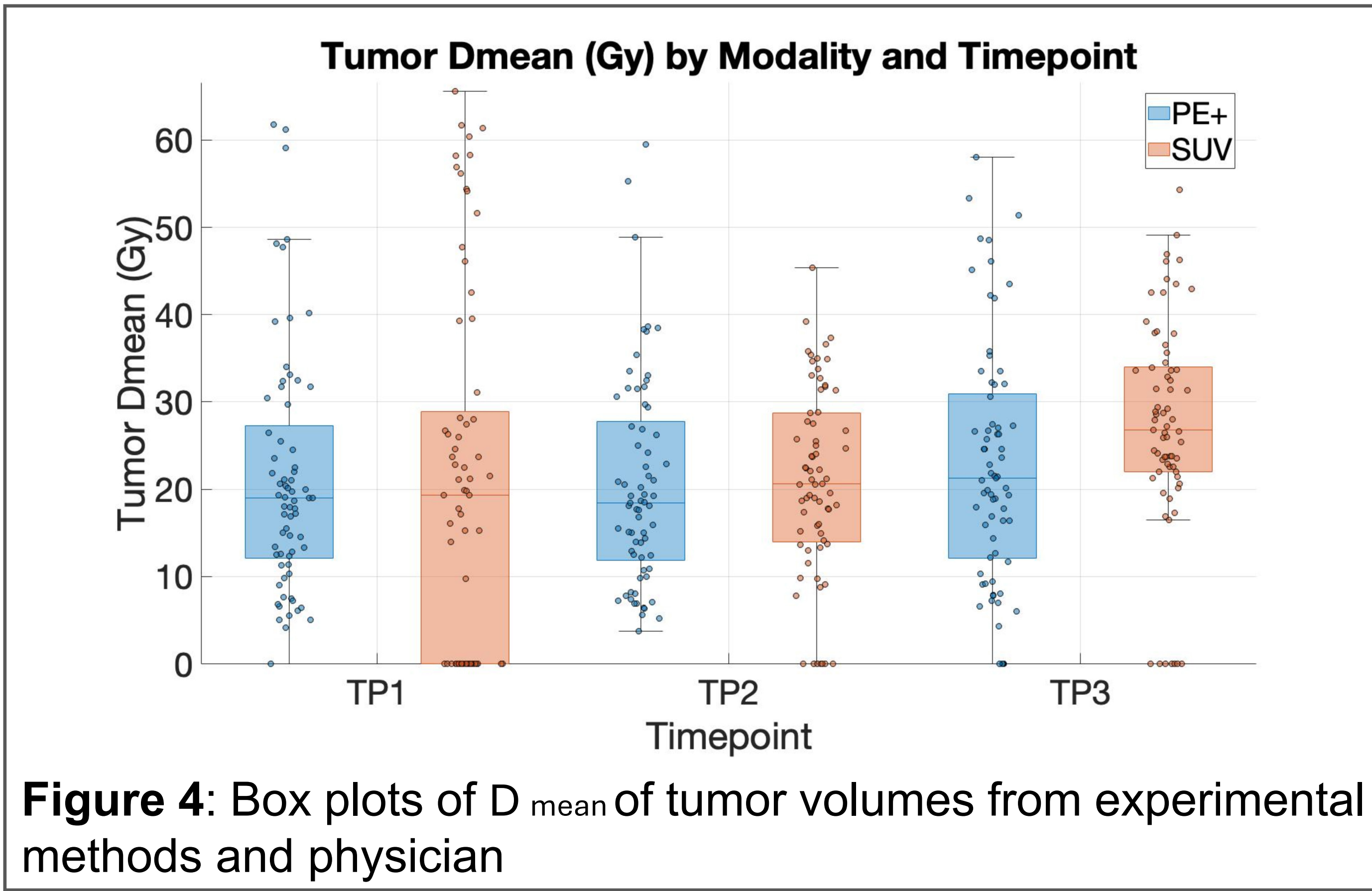


Figure 4: Box plots of D_{mean} of tumor volumes from experimental methods and physician

Discussion & Conclusions

- Using the same contour method on different TPs yields different contours which can significantly alter calculated dose
- Using the PE+ method on TP3 produced tumor contours with the greatest overlap with physician contours
- The SUV method is sensitive to the choice of TP
- Using the PE+ method showed more consistent tumor D_{mean}

References

- Uribe C, Peterson A, Van B, Fedrigo R, Carlson J, Sunderland J, Frey E, Dewaraja YK. An International Study of Factors Affecting Variability of Dosimetry Calculations, Part 1: Design and Early Results of the SNMMI Dosimetry Challenge. J Nucl Med. 2021 Dec;62(Suppl 3):36S-47S.

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