Zero-Shot Deep Learning-Based Segmentation of True and False Lumen in Type-B Aortic Dissection

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Introduction

- Type B aortic dissection (TBAD) is a potentially fatal tear in the descending aorta affecting 1.05-4.2 per 100,000 adults a year [1].
- Identification of morphological features through aortic segmentation is necessary for the management of TBAD patients
- Fully automated models for aortic segmentation have shown promise [2].
- However, these automated models require large expert-annotated datasets for training.
- Segment Anything Model (SAM) from MetaAI is a freely available deep-learning model that facilitates image segmentation without prior training

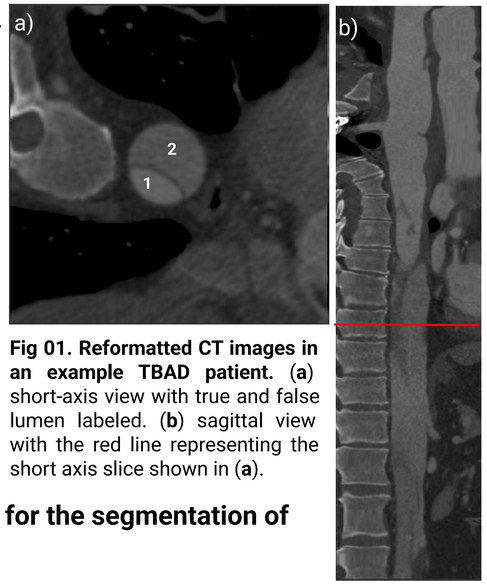

Fig 01. Reformatted CT images in an example TBAD patient. (**a**) short-axis view with true and false lumen labeled. (**b**) sagittal view with the red line representing the short axis slice shown in (**a**).

We aim to investigate the performance of SAM for the segmentation of true and false lumina in TBAD patients.

Methods & Materials

- 36 cases
- Implemented into Python v2023.12.0 (code available on request)

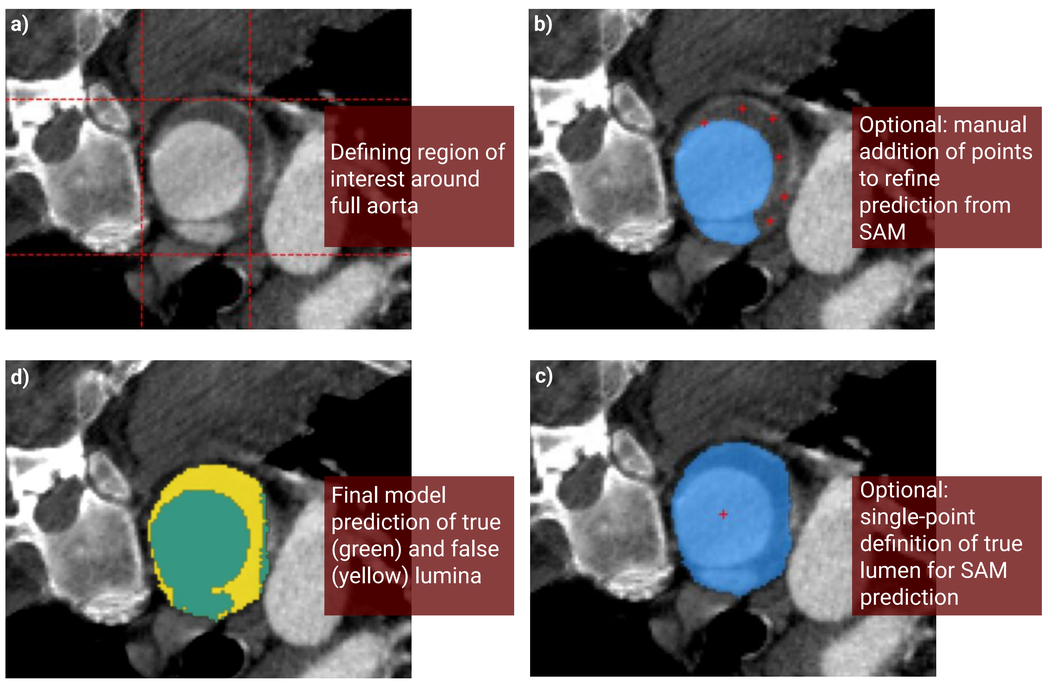

Fig. 02. Overview of segmentation procedure with SAM. (**a**) Define region of interest around aorta (**b**) optional: add points to refine initial prediction (**c**) single point definition of true lumen (**d**) final true and false lumen predictions

Results

1. Segmentation: Ground Truth vs. SAM

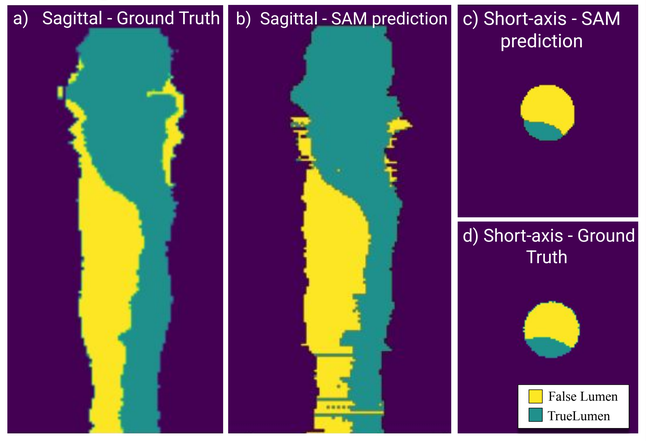

Fig. 03. Visual comparison between ground-truth segmentation and SAM prediction in an example TBAD patient. (**a-b**) Sagittal and (**c-d**) short-axis views of (**a,d**) ground-truth segmentations and (**b,c**) SAM predictions.

2. Segmentation: Accuracy

	Full Aorta	True Lumen	False Lumen
Dice score (interquartile range)	0.91 (0.89-0.92)	0.82 (0.76-0.83)	0.89 (0.85-0.91)

Fig. 04. Segmentation accuracy table for FA, TL and FL. The dice scores and interquartile ranges for FA, TL and FL.

3. Time per prediction

- The median time for SAM prediction was 28.66s (IQR: 22.27 - 45.68)

4. Volume: Ground Truth vs. SAM

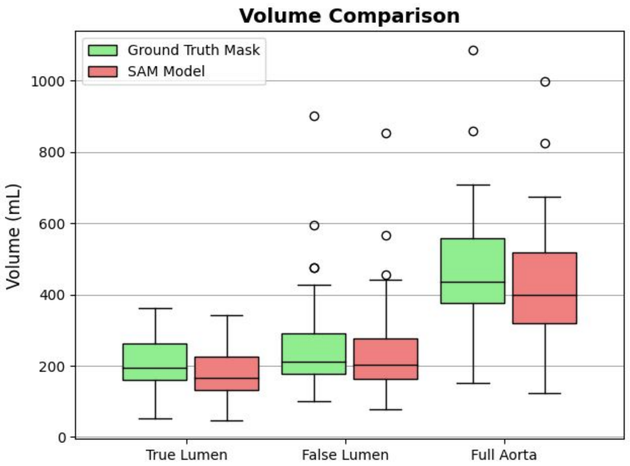

Fig. 05. Volume comparison between ground truth and SAM Model. Ground truth true lumen, false lumen, and full aorta volumes are represented in green and SAM model in red.

5. Limitations

- SAM model is sensitive to contrast and spatial resolution

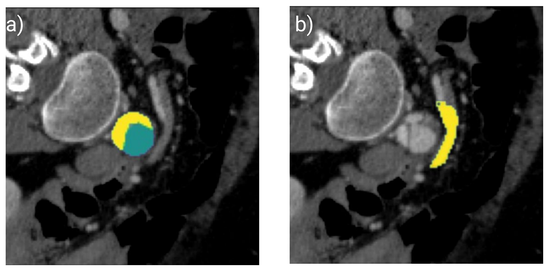

Fig. 06. Incorrect prediction. (**a**) Ground truth (**b**) SAM

Conclusions

- SAM is an easy-to-use and accurate tool for true and false lumen segmentation in TBAD patients
- These results demonstrate the potential utility of zero-shot learning models in the clinical management of type-b aortic dissection.

Acknowledgements

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[1] Patel AY, Eagle KA, Vaishnava P. Acute type B aortic dissection: insights from the International Registry of Acute Aortic Dissection. Ann Cardiothorac Surg. 2014;3(4):368-374. doi:10.3978/j.issn.2225-319X.2014.07.06 [2] Wobben LD, Codari M, Mistelbauer G, et al. Deep Learning-Based 3D Segmentation of True Lumen, False Lumen, and False Lumen Thrombosis in Type-B Aortic Dissection. Annu Int Conf IEEE Eng Med Biol Soc. 2021;2021:3912-3915. doi:10.1109/EMBC46164.2021.9631067