Appendix 1

Scanning Parameters and Names of Institutions

Cases from Center I (the First Affiliated Hospital, Zhejiang University School of Medicine) underwent non-contrast CT or CTA with Philips Brilliance iCT 256 (Philips Health Care, Cleveland, USA). The scanning parameters were as follows: tube voltage 120kv, tube current 300mA, matrix size 512 × 512, pitch 0.915, scanning speed 0.4s, scanning layer thickness 5mm, reconstruction layer thickness: 1mm. Scanning range is from 1cm above the aortic arch to the bifurcation of iliac artery. Iohexol contrast agent was used, and 1.5-2ml/kg of contrast agent was injected through the forearm through a high-pressure syringe at a flow rate of 4.5-5ml/s.

Cases from Center II (Zhejiang Hospital, affiliated to Zhejiang University School of Medicine) underwent non-contrast CT or CTA with Siemens Somatom Force. The scanning parameters were as follows: tube voltage 100kv, tube current automatic regulation (reference value 288mA), matrix size 512 × 512, pitch 1.5, scanning speed 0.5s, scanning layer thickness 5mm, reconstruction layer thickness: 0.6mm. Scanning range is from 1cm above the aortic arch to the bifurcation of iliac artery. Iohexol contrast agent was used, and 1.5-2ml/kg of contrast agent was injected through the forearm through a high-pressure syringe at a flow rate of 4.5ml/s.

Cases from Center III (Yiwu central hospital, affiliated to Wenzhou Medical University) underwent non-contrast CT or CTA with GE Optima CT 680 (General Electric Healthcare, Chicago, IL, USA). The scanning parameters were as follows: tube voltage 120kv, tube current 300mA, matrix size 512 × 512, pitch 1.375, scanning speed 0.6s, scanning layer thickness 5mm, reconstruction layer thickness: 0.625mm. Scanning range is from 1cm above the aortic arch to the bifurcation of iliac artery. Iohexol contrast agent was used, and 1.5-2ml/kg of contrast agent was injected through the forearm through a high-pressure syringe at a flow rate of 4.5ml/s.

Creating Sequences of Aorta Patches for Construction of AD Diagnostic Network

First, intra-slice aorta localization assigns bounding boxes in axial CT slices containing both ascending and descending aorta (e.g., at the aortic arch level) based on anatomical relationships: the ascending aorta positioned proximal part (cardiac proximity) and descending aorta located distal part (spinal proximity).

Second, inter-slice continuity verification maintains anatomical consistency through Intersection over Union (IoU) calculations between adjacent slices. For each bounding box in slice n, IoU values are computed against all candidate boxes in slice n+1, with pairs demonstrating maximum IoU (>0.7 threshold) linked as continuous aortic segments.

Finally, aortic patch processing involves cropping detected regions, resizing to 64 × 64 pixels, and axial stacking to construct 3D sequences (e.g., 7 consecutive slices) for subsequent 3D ResNet-34 network analysis.

Statistical Analysis

The AP@.5 was calculated as follows. First, its confidence scores sorted the predicted boxes in descending order. Then the precision and recall were calculated for each predicted box, as the threshold for matching the predicted and ground truth boxes used was set to 0.5 IoU. Then, the precision-recall curve was calculated by plotting the precision-recall pairs at various confidence thresholds. The area under the precision-recall curve was then calculated as the value of AP@.5. The AP@.5:.95 is the average of AP at IoU thresholds ranging from 0.5 to 0.95 with a step size of 0.05.

Implementation Details of Integrated Gradients

The Integrated Gradients (IG) method was implemented according to the definition by Sundararajan *et al.* (19). For each input CT slice, we used a zero-valued baseline with the same dimensions as the input image. The attributions were computed by accumulating the gradients along a straight-line path between the baseline and the input through 100 integration steps. Each slice was processed independently to generate 2D attribution maps, which were then reconstructed for 3D volumetric interpretation.

To enhance visualization, we normalized the attribution maps and overlaid them on the original CT images as heatmaps. *Figure S1* presents representative examples of these attributions. These visualizations reveal the model's focus areas and validate its attention to clinically relevant regions.

Workstation Specifications

The model was trained on a Dell 7920 workstation equipped with dual Intel Xeon 4215R processors, 128 GB

RAM, and an NVIDIA Quadro P6000 GPU.

Comparison of Atherosclerosis Between AD and Non-AD Groups

The prevalence of atherosclerosis is summarized in *Table S2*. In the ADDiN cohort, atherosclerosis were present in 60.9% (288/473) of AD patients versus 55.9% (217/388) of non-AD controls. Similarly, in the AoDN cohort, atherosclerosis was in 58.0% (51/88) of non-contrast CT cases and 57.8% (52/90) of CTA cases. Chi-square analysis showed no significant differences in atherosclerosis prevalence between AD and non-AD groups (ADDiN: $p=0.12$) or between imaging modalities (AoDN: $p>0.20$).

Table S1 Training Hyper-parameters for AoDN and ADDiN

Network	AoDN	ADDiN
Architecture	YOLOv5	ResNet-34
Pretrained Weights	No Pretrain	No Pretrain
Optimizer	SGD (momentum = 0.937)	Adam
Learning Rate	0.01	1e-4
Batch Size	32	16
Epochs	100	Max 60 (early stopping applied)
Learning Rate Schedule	Cosine Annealing	Step Decay (γ=0.1 every 20 epochs)

Abbreviations: AoDN, aorta detection network; ADDiN, aortic dissection diagnosis network.

Table S2 Comparison of Atherosclerosis Between AD and Non-AD Groups

Network	Cohort	Cases	Cases with atherosclerosis
AoDN	Non-contrast CT set	88	51
	CTA set	90	52
ADDiN	the AD cohort	473	288
	the non-AD cohort	388	217

Abbreviations: AoDN, aorta detection network; ADDiN, aortic dissection diagnosis network.

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Table S3 Summary of Previously Published Studies Pertaining to Automated Detection Solutions for AD

Parameter		Harris *et al.*, 2019 (12)	Yun *et al.*, 2020 (13)	Hata *et al.*, 2021 (15)	Xiong *et al.*, 2022 (14)	Huang *et al.*, 2022 (21)	Yi *et al.*, 2022 (22)	Cheng *et al.*, 2024 (23)	Laletin *et al.*, 2024 (24)	Current study
Types of studies		Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective
Institutions		Multicenter	One center	One center	Multicenter	One center	Multicenter	Multicenter	Multicenter	Multicenter
Medical imaging modalities		CTA	CTA	NCCT	NCCT	CTA	NCCT	NCCT	CTA	CTA & NCCT
Sample size		112 AD patients (34,577 cases)	43 AD patients (88 cases)	85 AD patients (170 cases)	93 AD patients (237 cases)	51 patients (298 cases)	185 AD patients (452 cases)	160 AD patients (320 cases)	137 AD patients (1303 cases)	388 AD patients (861 cases)
Architecture of CNN		5-layer CNN	DenseNet121	CNN Xception	3D nnU-Net	attention U-net and ResNeXt	2.5D U-net, ResNet34	The 3D full-resolution U-Net	2.5D U-Net	the YOLOv5, 3D ResNet-34
Model		2D	2D	2D	3D	3D	3D	3D	3D	3D
Performance comparison	Sensitivity	87.8%	82.2%	91.8%	93.8%	94.7%	86.2%	91.6%	94.2%	94.5%
	Specificity	96.0%	96.8%	88.2%	72.5%	95.4%	92.3%	95.6%	97.3%	91.7%
	Accuracy	96.9%	96.8%	90.0%	83.1%	96.6%	89.7%	93.8%	99.5%	92.8%
Key Contributions		Aortic rupture analysis	Morphology-based ROI extraction	Grad-CAM-based algorithm interpretation	NCCT to CTA conversion	Type A/B classification	Expert comparison (3 readers)	Segment the true and false lumens in aortic NCCT	Algorithmic screening, classification & prioritization	IG-based visualization of key aortic regions

Abbreviations: CTA, computed tomography angiography; AoDN, aorta detection network; ADDiN, aortic dissection diagnosis network; IG, integrated gradients; Grad-CAM, gradient-weighted class activation mapping; NCCT, non-contrast CT.

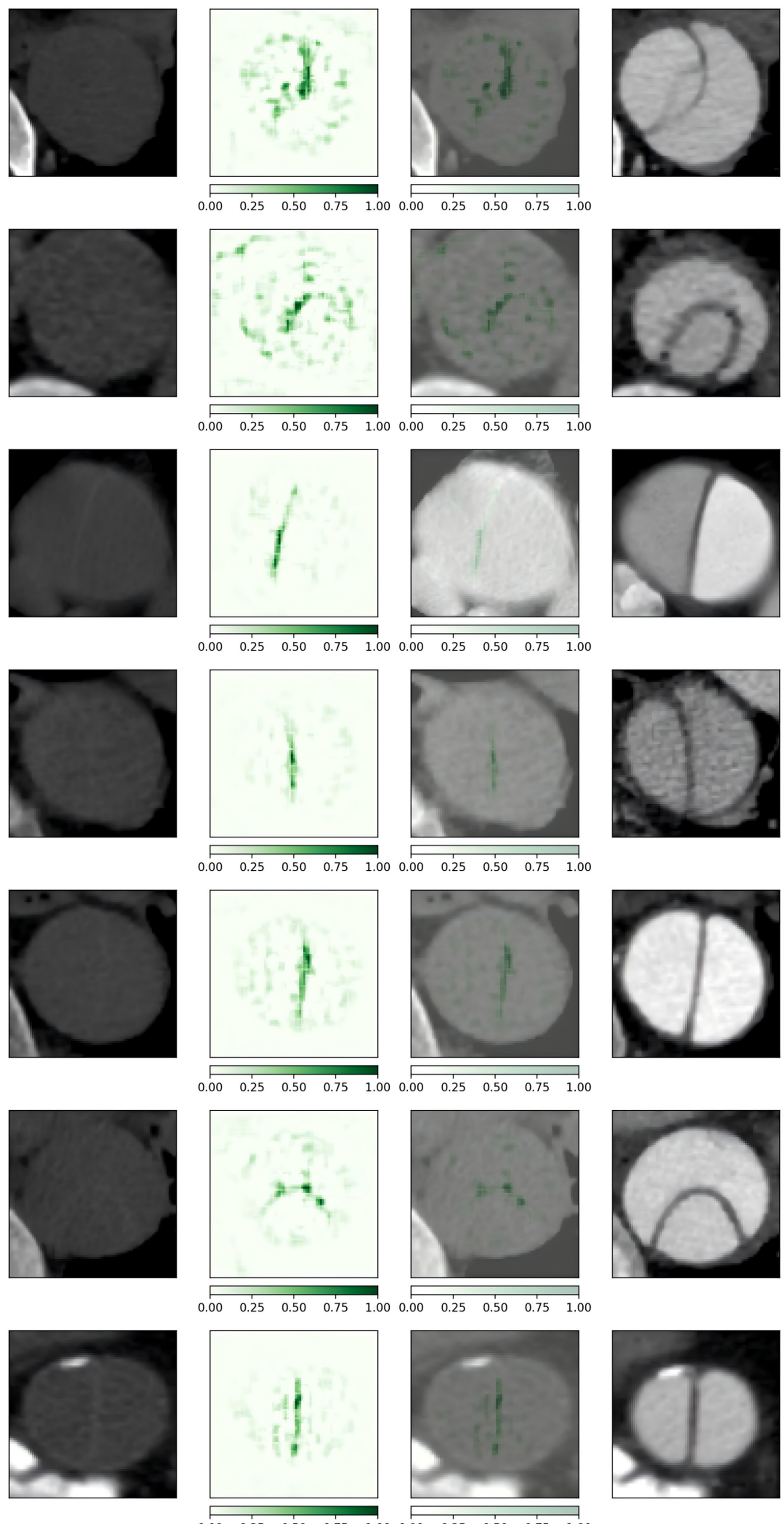

Figure S1 Visualization results of aortic dissection classification.

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