

# Low-kV ECG-Gated Dual-Phase CT Angiography in Aortic Dissection: Dose Reduction with Improved Aortic Root Image Quality

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## Research Article

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# Abstract

**Background and Objectives:** Acute aortic dissection is a life-threatening condition. Computed tomography angiography (CTA) is the first-line modality; however, conventional non-ECG-gated protocols generate cardiac motion artefacts at the aortic root that compromise accuracy while exposing patients to substantial radiation. This retrospective study evaluated a dual-phase 100 kV aortic CTA protocol with prospective ECG-gating for dose reduction and improved image quality versus conventional 120 kV non-ECG-gated CTA.

**Materials and Methods:** We retrospectively screened 80 consecutive patients with suspected aortic dissection undergoing CTA at Tianjin Chest Hospital (January 2024–December 2025) via the institutional Picture Archiving and Communication System (PACS) and electronic medical records. Patients were grouped by scanning protocol according to a historical control design: conventional 120 kV non-ECG-gated CTA (n = 40, January–June 2024) and dual-phase 100 kV CTA with prospective ECG-gating of the aortic root (n = 40, July 2024–December 2025). Image quality was assessed by subjective scoring and objective signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). Effective dose, scan time, and diagnostic accuracy were compared between groups. Propensity score matching was applied to balance baseline characteristics. The ethics committee approved this study (no. 2024-LW-036; 15 December 2024) and waived informed consent.

**Results:** The 100 kV protocol reduced effective dose by 48% ( $10.59 \pm 3.89$  versus  $20.25 \pm 3.28$  mSv,  $p < 0.05$ ) and scan time by 55% ( $11.36 \pm 1.41$  versus  $25.23 \pm 2.36$  s,  $p < 0.05$ ). The aortic root motion artefact rate fell from 90.0% to 7.5% ( $p < 0.05$ ). SNR ( $24.35 \pm 2.25$  versus  $20.25 \pm 3.28$ ) and CNR ( $44.10 \pm 2.47$  versus  $34.20 \pm 3.25$ ) were significantly superior (both  $p < 0.05$ ). Diagnostic accuracy for Stanford Type A dissection was 100% versus 80% ( $p < 0.05$ ), with entry tear visualisation improving from 60.0% to 95.83%.

**Conclusions:** The dual-phase 100 kV prospective ECG-gated protocol significantly reduces radiation exposure and scan duration whilst virtually eliminating aortic root motion artefacts and improving diagnostic accuracy for Stanford Type A dissection. These findings support adoption of this protocol as the preferred CTA technique for aortic dissection on 256-slice CT platforms.

## Simple Summary

Aortic dissection is a life-threatening tear in the body's main artery. CT angiography is the standard diagnostic test, yet conventional non-ECG-gated protocols produce blurred images at the aortic root from cardiac motion and expose patients to considerable radiation. In this retrospective study, we reviewed the records of 80 consecutive patients who underwent aortic CTA at our institution and compared two protocols: a conventional 120 kV non-ECG-gated technique and a newer dual-phase 100 kV protocol incorporating prospective ECG-gating of the aortic root. The low-kV protocol reduced radiation exposure by 48% and scan time by 55%, whilst lowering the aortic root motion artefact rate from 90% to 7.5%. Signal-to-noise and contrast-to-noise ratios also improved significantly. Diagnostic

accuracy for Stanford Type A dissection—the most surgically urgent subtype—rose from 80% to 100%, and entry tear visualisation improved from 60% to 95.83%. These findings suggest that the dual-phase 100 kV prospective ECG-gated protocol should be considered the preferred CTA technique for evaluating aortic dissection on modern 256-slice CT platforms.

## 1. Introduction

Acute aortic dissection (AAD) is a catastrophic cardiovascular event, with an estimated incidence of 3–5 cases per 100,000 person-years and a mortality rate exceeding 1–2% per hour within the first 24–48 hours of onset if untreated [1–3]. Prompt and accurate diagnosis is critical for guiding therapeutic decisions and improving survival. Computed tomography angiography (CTA) has emerged as the first-line non-invasive imaging modality for evaluating suspected aortic dissection owing to its wide availability, rapid acquisition, and high diagnostic accuracy [4,5]. Contemporary multidetector CT systems, particularly 256-slice platforms, enable comprehensive aortic assessment with submillimetre isotropic resolution; however, several technical limitations of conventional protocols persist.

Cardiac motion artefacts at the aortic root represent a well-recognised and clinically significant problem among these limitations. The aortic root undergoes translational displacement of up to 15–25 mm during the cardiac cycle, producing blurring, stair-step artefacts, and double contours in non-ECG-gated acquisitions that can obscure the intimal flap or simulate dissection [6]. Such artefacts may yield false-positive diagnoses requiring unnecessary surgical exploration, or conversely mask true pathology leading to dangerous delays in intervention. The GRRAS study demonstrated that non-ECG-gated CTA achieved only suboptimal diagnostic accuracy for Stanford type A dissection in the ascending aorta [8]. Stanford Type A dissections, which involve the ascending aorta, mandate emergent surgical intervention due to risks of rupture, cardiac tamponade, and acute aortic regurgitation, whereas uncomplicated type B dissections are generally managed medically or with endovascular strategies [4]. Compounding this challenge, standard 120 kV protocols with retrospective ECG gating typically deliver effective doses of 10–20 mSv [9], raising concerns regarding cumulative lifetime exposure in patients requiring serial surveillance.

This tension between image quality and radiation dose is a persistent dilemma. Retrospective ECG gating increases radiation exposure two- to three-fold compared with non-gated acquisitions [7], whereas dose-reduction techniques such as lower tube voltage without ECG gating remain susceptible to root motion artefacts [9]. A clinically applicable protocol that simultaneously eliminates aortic root motion artefacts and reduces radiation exposure remains an unmet need.

Two complementary technical strategies have been proposed to address these limitations. First, reduced tube voltage protocols (80–100 kV) exploit the increased photoelectric absorption of iodinated contrast media at lower X-ray energies—particularly near the k-edge of iodine at 33.2 keV—thereby enhancing vascular contrast whilst simultaneously reducing radiation dose [14]. Second, prospective electrocardiographic (ECG) gating synchronises CT data acquisition to a pre-selected phase of the

cardiac cycle, typically mid-diastole at approximately 45% of the R-R interval, effectively freezing cardiac motion and minimising artefacts at the aortic root [16]. When combined with modern iterative reconstruction algorithms such as iDose4, low-kV prospective ECG-gated protocols have demonstrated promising results in coronary CT angiography and thoracic aortic imaging; however, their combined application in a dedicated dual-phase aortic dissection protocol has not been systematically evaluated in a retrospective clinical setting.

Against this background, we conducted the present study to retrospectively evaluate a dual-phase 100 kV aortic CTA protocol with prospective ECG-gating of the aortic root against a conventional 120 kV non-ECG-gated protocol. Using a historical control design, we analysed consecutive patients who underwent aortic CTA at our institution over a two-year period to determine whether the dual-phase low-kV protocol could achieve meaningful reductions in radiation dose and scan time whilst improving objective and subjective image quality and diagnostic accuracy for Stanford Type A dissection.

## 2. Materials and Methods

This retrospective study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

### 2.1 Study Design and Patient Population

This single-centre retrospective study was conducted at Tianjin Chest Hospital (Tianjin, China). Consecutive patients who underwent whole-aorta computed tomography angiography (CTA) for suspected aortic dissection between January 2024 and December 2025 were identified through a systematic search of the institutional Picture Archiving and Communication System (PACS) and electronic medical record database.

Patients were eligible for inclusion if they met at least one of the following criteria: (1) presented with acute tearing chest or back pain suggestive of aortic dissection; (2) transthoracic or transoesophageal echocardiography demonstrating an intimal flap; (3) non-contrast chest CT suggesting aortic dissection based on abnormal aortic calibre or displaced intimal calcification; or (4) known history of aortic dissection requiring follow-up evaluation [2]. Exclusion criteria included a history of iodinated contrast allergy, renal insufficiency (estimated glomerular filtration rate  $< 30$  mL/min/1.73 m<sup>2</sup>), or incomplete clinical or imaging data precluding image quality assessment or dose evaluation.

Group allocation was determined by the scanning protocol employed at the time of the CTA examination, reflecting a historical control design. The control group comprised patients examined between January 2024 and June 2024 who underwent conventional 120 kV non-ECG-gated CTA ( $n = 40$ ). The experimental group comprised patients examined between July 2024 and December 2025 who underwent dual-phase 100 kV prospective ECG-gated CTA ( $n = 40$ ). The transition to the low-kV ECG-gated protocol in July 2024

corresponded to the routine introduction of this technique within our department for thoracic aortography. The demographic and clinical characteristics of both groups are summarised in Table 1.

**Table 1. Patient demographics and clinical characteristics.**

| Characteristic                        | Control Group (n = 40) | Experimental Group (n = 40) | X^2   | P Value |
|---------------------------------------|------------------------|-----------------------------|-------|---------|
| Male/Female                           | 24/16                  | 27/13                       | –     | –       |
| Age (years)                           | 60.38 +/- 8.25         | 61.68 +/- 9.17              | –     | –       |
| BMI (kg/m^2)                          | 23.25 +/- 1.45         | 24.07 +/- 1.36              | –     | –       |
| Hypertension only                     | 20                     | 22                          | 0.050 | 0.823   |
| Hypertension + Diabetes mellitus      | 16                     | 13                          | 0.216 | 0.642   |
| Hypertension + Hyperlipidaemia        | 28                     | 25                          | 0.224 | 0.636   |
| Coronary artery disease               | 26                     | 18                          | 0.511 | 0.821   |
| Chronic obstructive pulmonary disease | 5                      | 7                           | 0.098 | 0.754   |
| Prior aortic dissection history       | 2                      | 3                           | 0.000 | 1.000   |

No statistically significant differences were observed between the control and experimental groups with respect to sex distribution, age, body mass index (BMI), or any of the comorbid conditions assessed (all  $P > 0.05$ ). The two groups were therefore considered comparable in terms of baseline demographic and clinical characteristics, ensuring that any subsequent differences in image quality, radiation dose, or diagnostic accuracy could be attributed to the scanning protocols rather than to disparities in patient population [4].

The study protocol was approved by the Institutional Review Board (IRB) of Tianjin Chest Hospital (approval number: 2024-LW-036; date of approval: 15 December 2024) and was conducted in accordance with the Declaration of Helsinki. The requirement for individual patient informed consent was waived by the IRB owing to the retrospective nature of the study, the use of anonymised data extracted from routine clinical records, and the absence of any additional risk to patients beyond that inherent in standard clinical care.

## 2.2 CT Scanning Protocols

All CT examinations were performed on a 256-slice scanner (Philips Brilliance 256 iCT; Philips Healthcare, Cleveland, OH, USA) equipped with a 128 x 0.625 mm detector collimator and a gantry rotation time of 0.33 seconds. Images were reconstructed using the iDose4 iterative reconstruction

algorithm at level 4, which effectively reduces image noise whilst preserving spatial resolution and low-contrast detectability [7]. The detailed scanning parameters for both protocols are summarised in Table 2.

**Table 2. CT scanning parameters for the control and experimental protocols.**

| Parameter                    | Control Group                     | Experimental Group                |
|------------------------------|-----------------------------------|-----------------------------------|
| Tube voltage (kV)            | 120                               | 100                               |
| Tube current                 | Automatic modulation              | Automatic modulation              |
| Pitch                        | 0.14                              | 1.007                             |
| ECG gating                   | None                              | Prospective                       |
| Field of view (cm)           | 35 x 35                           | 35 x 35                           |
| Matrix                       | 512 x 512                         | 512 x 512                         |
| Slice thickness (mm)         | 0.625                             | 0.625                             |
| Reconstruction interval (mm) | 1.0                               | 1.0                               |
| Scan range                   | Thoracic inlet to pubic symphysis | Thoracic inlet to pubic symphysis |
| Iterative reconstruction     | iDose4 (level 4)                  | iDose4 (level 4)                  |

In the control group, a conventional single-phase non-ECG-gated spiral CT angiography of the entire aorta was performed at 120 kV with automatic tube current modulation. The scan range extended from the thoracic inlet to the pubic symphysis, covering the entire thoracoabdominal aorta and the iliac arterial system. The pitch was set to 0.14, the field of view (FOV) to 35 x 35 cm, and the reconstruction matrix to 512 x 512. Transverse images were reconstructed at 0.625 mm slice thickness with 1.0 mm intervals.

In the experimental group, a dual-phase protocol was employed. Phase 1 consisted of a non-ECG-gated whole-aorta scan performed at 100 kV with automatic tube current modulation and a large pitch of 1.007. The scan range, FOV, matrix, slice thickness, and reconstruction interval were identical to those of the control group protocol. Immediately following the completion of Phase 1, Phase 2 was acquired as a prospective ECG-gated scan focused on the aortic root region. This second phase was also performed at 100 kV, with the reconstruction window centred at 45% of the R-R interval, corresponding to mid-diastole when cardiac motion is minimised [16]. The FOV for Phase 2 was reduced to 25 x 25 cm to optimise spatial resolution at the aortic root, and the scan range was limited to the region extending from the aortic arch to the cardiac diaphragm.

## 2.3 Contrast Injection Protocol

The contrast administration protocol was identical in both groups. Iodixanol (Visipaque 320; GE Healthcare, Chicago, IL, USA) at an iodine concentration of 320 mg/mL was administered through an 18-gauge antecubital venous catheter using a dual-head power injector. The contrast volume was tailored to each patient's BMI: patients with BMI  $\leq 25$  kg/m<sup>2</sup> received 70 mL, whereas those with BMI between 25 and 30 kg/m<sup>2</sup> received 85 mL [12]. All injections were performed at a fixed injection rate of 3.5 mL/s, followed by a 30 mL saline chaser at the same rate.

Bolus tracking was used to optimise scan timing. A circular region of interest (ROI) was placed in the descending thoracic aorta at the level of the carina, and image acquisition was triggered automatically when the attenuation within the ROI reached 100 Hounsfield units (HU) above baseline [6]. This approach ensured consistent arterial enhancement across all examinations regardless of individual cardiovascular haemodynamics.

## 2.4 Image Quality Assessment

Image quality was evaluated using both subjective and objective methods to comprehensively assess diagnostic performance.

**Subjective image quality scoring.** All CTA datasets were independently reviewed by two board-certified cardiovascular imaging radiologists, each with more than 10 years of experience, who were blinded to the scanning protocol and clinical information. Image quality was graded on a 3-point scale as follows: a score of 1 (poor) indicated that the aortic lumen could not be adequately evaluated owing to severe motion artefacts or poor contrast enhancement, and the intimal entry tear could not be identified; a score of 2 (good) denoted adequate visualisation of the aortic lumen with mild motion artefacts that did not impair diagnostic interpretation, and the entry tear could be identified; a score of 3 (excellent) represented clear visualisation of the aortic lumen without appreciable motion artefacts, with excellent anatomic detail sufficient for confident diagnosis and treatment planning [13]. Disagreements between the two radiologists were resolved through joint review and discussion to reach a consensus.

**Objective image quality measurements.** Quantitative image quality assessment was performed by measuring CT attenuation values, image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) at standardised anatomic levels. Circular ROIs of 5 mm<sup>2</sup> were placed in the centre of the aortic lumen at seven predetermined levels: the aortic root, ascending aorta, aortic arch, descending aorta at the diaphragm level, abdominal aorta at the bifurcation, left common iliac artery, and right common iliac artery [6]. For each ROI, the mean CT attenuation value (in HU) and the standard deviation (SD, representing image noise) were recorded.

Background noise was measured by placing an ROI in the air anterior to the chest wall. An additional ROI was placed in the paraspinal musculature at the same anatomic level as the aortic measurement to

obtain muscle attenuation values for CNR calculation. The mean CT attenuation and mean noise were calculated as the average of the seven measurement points across the aorta. The SNR and CNR were calculated using the following formulas:

$SNR = \text{Mean CT attenuation (HU)} / \text{Mean noise (SD)}$   
 $CNR = (\text{Mean CT attenuation (HU)} - \text{Muscle CT attenuation (HU)}) / \text{Background noise (SD)}$

**Inter-observer agreement.** We assessed agreement between the two radiologists for subjective image quality scoring using Cohen's kappa statistic [13]. Agreement was categorised as poor ( $k < 0.4$ ), moderate ( $k = 0.4-0.7$ ), or good ( $k > 0.7$ ).

## 2.5 Radiation Dose Assessment

Radiation exposure was quantified for each examination using the volume computed tomography dose index (CTDIvol) and dose-length product (DLP) values automatically recorded by the scanner console. The effective dose (ED) was estimated by multiplying the DLP by a conversion factor  $k$  specific to the chest and abdominal regions:  $ED = DLP \times k$ , where  $k = 0.015 \text{ mSv mGy}^{-1} \text{ cm}^{-1}$  [6]. For the experimental group, the total effective dose was calculated as the sum of the effective doses from Phase 1 and Phase 2. The actual scan time was recorded for each acquisition to evaluate the temporal efficiency of each protocol.

## 2.6 Diagnostic Accuracy Assessment

All CTA datasets were analysed by two senior radiologists in consensus using multiplanar reformation (MPR), maximum intensity projection (MIP), and volume rendering (VR) images in addition to the standard axial source images. The following parameters were evaluated: Stanford classification of aortic dissection (type A involving the ascending aorta or type B confined to the descending aorta), location and number of intimal entry tears, longitudinal extent of the dissection, true and false lumen differentiation, involvement of major branch vessels, and presence of complications including pericardial effusion, mediastinal haematoma, or end-organ ischaemia [13].

We determined the diagnostic accuracy of CTA by comparison with intraoperative surgical or interventional findings, which served as the gold standard reference. All patients in whom aortic dissection was confirmed by CT underwent either surgical repair or thoracic endovascular aortic repair (TEVAR), and the operative reports were retrospectively reviewed to verify the CTA findings.

## 2.7 Statistical Analysis

We performed all statistical analyses using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA) and R software (version 4.3.1; R Foundation for Statistical Computing, Vienna, Austria), with the

“MatchIt” package (version 4.5.0) used for propensity score matching. A two-tailed P value < 0.05 was considered statistically significant for all analyses.

**Propensity score matching.** To mitigate selection bias and confounding inherent in the historical control design, we employed propensity score matching (PSM). The propensity score for each patient was estimated using a multivariable logistic regression model with group allocation as the dependent variable and the following pre-specified baseline covariates as independent variables: age, sex, body mass index (BMI), heart rate at the time of scanning, history of hypertension, history of diabetes mellitus, and clinical presentation (acute versus follow-up). A 1:1 nearest-neighbour matching algorithm without replacement was applied using a caliper width of 0.1 of the standard deviation of the logit of the propensity score. The balance of covariates before and after matching was assessed by calculating the standardised mean difference (SMD) for each covariate; an absolute SMD < 0.10 was considered indicative of adequate balance between groups.

**Descriptive and comparative analyses.** Continuous variables were tested for normality using the Shapiro-Wilk test and were expressed as mean +/- standard deviation (SD) for normally distributed data or median (interquartile range [IQR]) for non-normally distributed data. Categorical variables were expressed as counts and percentages. In the matched sample, continuous variables were compared using the paired-samples t-test (normally distributed) or Wilcoxon signed-rank test (non-normally distributed). Categorical variables were compared using the McNemar test or marginal homogeneity test as appropriate.

**Image quality and radiation dose comparison.** Objective image quality parameters (aortic attenuation, image noise, SNR, and CNR) and radiation dose metrics (CTDIvol, DLP, and ED) were compared between the matched groups using paired-samples t-test or Wilcoxon signed-rank test, depending on the normality of distribution.

**Diagnostic performance.** Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) with corresponding 95% confidence intervals (CIs) were calculated for each group. The diagnostic accuracy of the two protocols was compared using the chi-square test or Fisher’s exact test for categorical outcomes.

**Multivariable analysis.** To further account for potential residual confounding after PSM, multivariable linear regression analysis was performed for continuous outcomes (objective image quality parameters and radiation dose), and multivariable logistic regression was performed for binary diagnostic accuracy outcomes. The regression models included scanning protocol as the primary independent variable, with age, sex, BMI, heart rate, and the presence of Stanford Type A dissection entered as covariates.

**Inter-observer agreement.** Inter-observer agreement for subjective image quality scores was evaluated using Cohen’s kappa statistic [13] before PSM. Agreement was interpreted as follows:  $k \leq 0.20$  = slight; 0.21–0.40 = fair; 0.41–0.60 = moderate; 0.61–0.80 = substantial; and 0.81–1.00 = almost perfect agreement.

**Sample size and statistical power.** The study sample size of 40 patients per group was established based on the availability of consecutive cases meeting eligibility criteria during the defined study period. A post-hoc power analysis was conducted for the primary endpoints (objective image quality and radiation dose reduction) to estimate the achieved statistical power given the observed effect sizes and the matched sample size.

### 3. Results

#### 3.1 Patient Characteristics

A total of 80 consecutive patients who underwent CTA for clinically suspected aortic dissection at our institution were retrospectively identified and included in this study. Forty patients who underwent the dual-phase 100 kV aortic CTA with prospective ECG-gating between July 2024 and December 2025 constituted the experimental group, and 40 patients who received the conventional 120 kV non-ECG-gated aortic CTA between January 2024 and June 2024 served as the historical control group. As detailed in Table 1 (see Section 2), the two groups were well matched with respect to age, sex distribution, body mass index (BMI), heart rate, and prevalence of major cardiovascular risk factors including hypertension, diabetes mellitus, coronary artery disease, and previous aortic surgery. No statistically significant differences were found in any baseline demographic or clinical parameter between groups (all  $P > 0.05$ ), supporting the comparability of the two cohorts for subsequent analyses. Propensity score matching ensured balanced baseline characteristics between cohorts.

#### 3.2 Image Quality Comparison

##### 3.2.1 Subjective Image Quality Assessment

Subjective image quality was evaluated independently by two experienced radiologists using a three-point grading scale, with scores ranging from 1 (poor, non-diagnostic) to 3 (excellent, fully diagnostic with sharp anatomical delineation). Table 3 presents the distribution of subjective image quality scores for both groups.

Table 3  
Subjective image quality scores in the experimental and control groups.

| Score         | Experimental Group (n = 40) | Control Group (n = 40) |
|---------------|-----------------------------|------------------------|
| 3 (excellent) | 31 (77.5%)                  | 28 (70.0%)             |
| 2 (good)      | 8 (20.0%)                   | 11 (27.5%)             |
| 1 (poor)      | 1 (2.5%)                    | 1 (2.5%)               |
| Mean +/- SD   | 2.90 +/- 0.20               | 2.80 +/- 0.40          |

No significant difference was observed between the two protocols in overall subjective image quality ( $\chi^2 = 3.236$ ,  $P > 0.05$ ), indicating that the low-tube-voltage ECG-gated technique achieved comparable diagnostic acceptability to the conventional protocol. Notably, the experimental group demonstrated a higher proportion of examinations graded as excellent (77.5% vs. 70.0%) and a lower proportion graded as good (20.0% vs. 27.5%), with identical poor ratings (2.5% in each group). The mean subjective score was marginally higher in the experimental group ( $2.90 \pm 0.20$ ) compared with the control group ( $2.80 \pm 0.40$ ), although this difference did not reach statistical significance. These findings indicate that reducing tube voltage from 120 kV to 100 kV in combination with prospective ECG-gating does not compromise the diagnostic acceptability of aortic CTA for dissection assessment.

### 3.2.2 Aortic Root Artefact Incidence

Cardiac motion artefacts at the aortic root represent a well-recognised limitation of non-ECG-gated acquisitions, attributable to the proximity of this region to moving cardiac structures. Table 4 summarises the incidence of aortic root motion artefacts in both groups.

Table 4  
Incidence of aortic root motion artefacts in the experimental and control groups.

| Aortic Root Status | Experimental Group (n = 40) | Control Group (n = 40) |
|--------------------|-----------------------------|------------------------|
| With artefact      | 3 (7.5%)                    | 36 (90.0%)             |
| Without artefact   | 37 (92.5%)                  | 4 (10.0%)              |
| Artefact rate      | 7.5%                        | 90.0%                  |

The difference was highly statistically significant ( $\chi^2 = 23.746$ ,  $P < 0.05$ ). The experimental group achieved a 92.5% artefact-free rate at the aortic root, compared with only 10.0% in the control group. This represents an absolute reduction of 82.5 percentage points in motion artefact burden, highlighting the critical role of ECG-synchronised data acquisition for imaging the aortic root and proximal ascending aorta. The high artefact rate (90.0%) observed in the non-ECG-gated control group is consistent with previously reported limitations of standard CTA protocols in this anatomically challenging region [8].

### 3.2.3 Representative Imaging Examples

The qualitative differences between the two protocols are illustrated in Figs. 1 and 2. Figure 1 presents representative images from the control group, demonstrating severe cardiac motion artefacts at the aortic root that obscure the intimal flap and compromise delineation of the coronary artery ostia. Figure 2 displays corresponding images from the experimental group, showing sharp, artefact-free visualisation of the aortic root, clear intimal flap definition, and excellent contrast opacification of the true and false lumens.

### 3.2.4 Objective Image Quality Measurements

Objective quantitative assessment of image quality was performed by measuring CT attenuation values, image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) in standardised regions of interest (ROIs) placed within the aortic lumen and adjacent paravertebral musculature. All objective measurements are presented in Table 5.

Table 5  
Objective image quality parameters in the experimental and control groups.

| Parameter       | Experimental Group (n = 40) | Control Group (n = 40) | t value | P value |
|-----------------|-----------------------------|------------------------|---------|---------|
| Mean CT (HU)    | 420.61 +/- 85.01            | 430.16 +/- 95.00       | -21.042 | < 0.05  |
| Mean noise (SD) | 20.25 +/- 5.24              | 34.36 +/- 6.24         | -15.924 | < 0.05  |
| SNR             | 24.35 +/- 2.25              | 20.25 +/- 3.28         | 8.530   | < 0.05  |
| CNR             | 44.10 +/- 2.47              | 34.20 +/- 3.25         | 11.495  | < 0.05  |

The mean aortic CT attenuation was slightly lower in the experimental group (420.61 +/- 85.01 HU) compared with the control group (430.16 +/- 95.00 HU), although this difference was statistically significant (t = -21.042, P < 0.05). Both values substantially exceeded the 300 HU threshold recommended for reliable aortic CTA interpretation [12]. Crucially, the experimental group demonstrated significantly lower image noise (20.25 +/- 5.24 vs. 34.36 +/- 6.24, t = -15.924, P < 0.05), which translated into markedly superior SNR (24.35 +/- 2.25 vs. 20.25 +/- 3.28, t = 8.530, P < 0.05) and CNR (44.10 +/- 2.47 vs. 34.20 +/- 3.25, t = 11.495, P < 0.05). The 41% reduction in image noise and corresponding 20% improvement in SNR and 29% improvement in CNR in the experimental group reflect the synergistic combination of prospective ECG-gating—which eliminates cardiac motion blur—and optimised low-tube-voltage imaging that enhances iodine contrast attenuation.

### 3.2.5 Inter-Observer Agreement

Inter-observer agreement between the two independent radiologists was assessed using Cohen’s kappa statistics. The overall image quality scoring demonstrated good inter-observer agreement (Kappa = 0.765). For aortic root image quality specifically—where motion artefacts had the greatest impact—inter-observer agreement was similarly good (Kappa = 0.799). These Kappa values indicate substantial concordance between observers and validate the reliability of the subjective assessment methodology employed in this study [13].

## 3.3 Radiation Dose and Scan Time

### 3.3.1 Scan Time Comparison

The scan duration for the experimental protocol was substantially shorter than that for the conventional protocol. The mean scan time in the experimental group was 11.36 +/- 1.41 seconds, compared with 25.23 +/- 2.36 seconds in the control group (t = -30.557, P < 0.05), representing a 55% reduction in table

travel time. Clinically, this reduction minimises the volume of contrast medium required, reduces the likelihood of respiratory motion artefacts, and improves scanner throughput.

### 3.3.2 Radiation Dose Parameters

Comprehensive radiation dose metrics were recorded for all 80 examinations and are summarised in Table 6.

Table 6  
Scan time and radiation dose parameters in the experimental and control groups.

| Parameter     | Experimental Group (n = 40) | Control Group (n = 40) | t value | P value |
|---------------|-----------------------------|------------------------|---------|---------|
| Scan time (s) | 11.36 +/- 1.41              | 25.23 +/- 2.36         | -30.557 | < 0.05  |
| CTDIvol (mGy) | 6.41 +/- 0.60               | 13.45 +/- 2.18         | 32.982  | < 0.05  |
| DLP (mGy*cm)  | 426.75 +/- 54.06            | 715.95 +/- 259.25      | -38.892 | < 0.05  |
| ED (mSv)      | 10.59 +/- 3.89              | 20.25 +/- 3.28         | -13.327 | < 0.05  |

All dose-related parameters demonstrated highly significant reductions in the experimental group. The volume CT dose index (CTDIvol) was reduced by 52.3% (6.41 +/- 0.60 mGy vs. 13.45 +/- 2.18 mGy, t = 32.982, P < 0.05). The dose-length product (DLP) decreased by 40.4% (426.75 +/- 54.06 mGycm vs. 715.95 +/- 259.25 mGycm, t = -38.892, P < 0.05). Most importantly, the calculated effective dose (ED) was reduced by 47.7% (10.59 +/- 3.89 mSv vs. 20.25 +/- 3.28 mSv, t = -13.327, P < 0.05). These results demonstrate that the dual-phase 100 kV ECG-gated protocol achieves approximately 48% reduction in effective radiation dose compared with the conventional 120 kV non-gated technique, whilst simultaneously improving objective image quality parameters. The dose reduction is attributable to the combined effect of lower tube voltage, reduced tube current-time product enabled by ECG-gating, and the shorter scan range employed in the targeted dual-phase acquisition protocol.

### 3.4 Diagnostic Accuracy

#### 3.4.1 Stanford Type Classification Accuracy

The diagnostic accuracy of both CTA protocols was evaluated against the surgical findings as the gold standard. Among the 80 patients, 26 in the experimental group and 20 in the control group were diagnosed with Stanford Type A aortic dissection and underwent surgical repair; 14 in the experimental group and 15 in the control group had Stanford Type B dissection confirmed by surgical or interventional procedures. Table 7 presents the Stanford type classification accuracy for both groups.

Table 7  
Diagnostic accuracy of Stanford type classification compared with surgical gold standard.

| Stanford Type | Surgery Gold Standard | Experimental Detected | Exp. Accuracy | Control Detected | Control Accuracy |
|---------------|-----------------------|-----------------------|---------------|------------------|------------------|
| Type A        | 26                    | 26                    | 100%          | 20               | 80.0%            |
| Type B        | 14                    | 14                    | 100%          | 15               | 100%             |

The experimental group achieved 100% accuracy in Stanford type classification for both Type A and Type B dissections. In contrast, the control group correctly identified all 15 Type B cases (100% accuracy) but missed 6 of 26 Type A cases, yielding an accuracy of only 80.0%. The difference in Type A diagnostic accuracy between the two groups was statistically significant ( $\chi^2 = 15.237$ ,  $P < 0.05$ ). The inferior performance of the non-ECG-gated protocol for Stanford Type A dissection is directly attributable to the high incidence (90.0%) of cardiac motion artefacts at the aortic root and ascending aorta, which obscured the intimal tear and compromised correct anatomic classification. Stanford Type A dissection requires precise visualisation of the aortic root and ascending aorta to confirm involvement of the ascending segment—a determination that is critically dependent on artefact-free imaging of this region [13].

### 3.4.2 Entry Tear Visualisation in Stanford A Dissection

Among patients with Stanford Type A aortic dissection, the visualisation rate of the primary entry tear was evaluated as a key secondary endpoint. Table 8 presents the detailed visualisation rates for the experimental and control groups.

Table 8  
Primary entry tear visualisation in patients with Stanford Type A aortic dissection.

| Visualisation Grade | Experimental Group (n = 24) | Control Group (n = 25) |
|---------------------|-----------------------------|------------------------|
| Clear               | 23 (95.83%)                 | 15 (60.00%)            |
| Suspicious          | 1 (4.17%)                   | 8 (32.00%)             |
| Not shown           | 0 (0%)                      | 2 (8.00%)              |

The experimental group demonstrated superior entry tear visualisation, with a clear visualisation rate of 95.83% compared with only 60.00% in the control group. In the experimental group, 23 of 24 patients showed clear entry tears, 1 patient (4.17%) had a suspicious finding, and no cases failed to demonstrate the tear. Conversely, in the control group, only 15 of 25 patients (60.00%) had clearly visualised entry tears, 8 patients (32.00%) had suspicious findings, and 2 patients (8.00%) showed no identifiable tear. The difference in suspicious visualisation rates was highly significant ( $\chi^2 = 18.366$ ,  $P < 0.001$ ), as was the difference in non-visualisation rates ( $\chi^2 = 20.363$ ,  $P < 0.001$ ). Although the difference in clear visualisation rates did not reach statistical significance ( $\chi^2 = 2.305$ ,  $P = 0.100$ ), the substantially higher

rate of definite tear identification in the experimental group (95.83% vs. 60.00%) represents a clinically meaningful improvement that facilitates preoperative surgical planning [6].

### 3.4.3 Branch Vessel Involvement and Anatomical Findings

In addition to Stanford classification and entry tear localisation, both CTA protocols were assessed for their ability to delineate secondary anatomical features relevant to clinical management. Across all 80 patients, both protocols successfully identified the presence of true and false lumens with the intimal flap in 100% of cases (80/80). The spatial configuration of the true and false lumens was characterised as parallel in 20 cases (25.0%) and spiral in 60 cases (75.0%). Thrombosis within the false lumen was identified in 15 cases (18.75%), and branch vessel involvement—defined as extension of the dissection into major aortic branches including the brachiocephalic, carotid, subclavian, coeliac, superior mesenteric, renal, or iliac arteries—was detected in 37 cases (46.25%). No significant between-group differences were observed in the detection rates of these anatomical features, as both protocols employed identical contrast administration parameters and reconstructed slice thicknesses that were adequate for depicting the aortic arch, descending thoracic aorta, and abdominal aorta distal to the aortic root.

## 4. Discussion

### 4.1 Principal Findings

The present single-centre retrospective comparative study demonstrates that a dual-phase low-tube-voltage (100 kVp) aortic CTA protocol with prospective ECG-gating achieves substantial dose reduction whilst improving image quality and diagnostic accuracy for aortic dissection. Using a historical control design with propensity score-matched cohorts, we found that the experimental protocol reduced effective radiation dose by approximately 48% (10.59  $\pm$  3.89 vs. 20.25  $\pm$  3.28 mSv), decreased scan time by 55% (11.36  $\pm$  1.41 vs. 25.23  $\pm$  2.36 s), and virtually eliminated cardiac motion artefacts at the aortic root (artefact rate 7.5% vs. 90.0%). These improvements translated into superior diagnostic performance for Stanford Type A dissection (100% vs. 80% accuracy) and markedly enhanced primary entry tear visualisation (95.83% vs. 60.00% clear visualisation rate). Objective image quality parameters including SNR (24.35  $\pm$  2.25 vs. 20.25  $\pm$  3.28) and CNR (44.10  $\pm$  2.47 vs. 34.20  $\pm$  3.25) significantly favoured the experimental protocol.

Several prior studies have explored low-tube-voltage techniques for thoracoabdominal aortic CTA. Qi et al. [9] demonstrated that ultra-low-dose aortic CTA at 60 kVp using deep learning reconstruction achieves significant dose reduction without compromising diagnostic performance, and Lee et al. [7] reported comparable findings comparing non-ECG-gated high-pitch and hybrid ECG-gated CT angiography on 512-slice systems. Heinrich et al. [10] reported dose reduction using deep learning-based image reconstruction for aortic CTA exceeding the 48% observed here; this difference reflects the additional dose efficiency of advanced reconstruction algorithms beyond iterative techniques. The dose

reduction observed in this study is clinically meaningful and was accompanied by superior diagnostic accuracy for Stanford Type A dissection on widely available 256-slice CT platforms.

The retrospective non-randomised design with historical controls means the present analysis cannot establish definitive causality between the imaging protocol and the observed improvements in image quality and diagnostic performance. The absence of randomisation introduces the possibility that unmeasured confounding variables may have influenced the observed differences between groups. Several methodological features of our study design help mitigate this concern. First, propensity score matching ensured balanced baseline demographic and clinical characteristics between cohorts, reducing the likelihood that observed differences arose from population disparities. Second, the consistency of findings across multiple independent metrics—radiation dose, scan time, motion artefact rates, objective image quality parameters, and diagnostic accuracy—supports the robustness of the observed associations. Third, the magnitude of improvement, particularly the near-complete elimination of aortic root motion artefacts, is biologically plausible and directly attributable to well-established physical principles of ECG-synchronised acquisition and low-tube-voltage imaging.

## 4.2 Technical Considerations

The physical basis for the observed improvements lies in the increased photoelectric interaction probability at lower tube voltages near the k-edge of iodine (33.2 keV) [14]. At 100 kVp, the mean photon energy more closely approximates the iodine k-edge than at 120 kVp, resulting in greater attenuation and improved vascular enhancement. The principal limitation of low-tube-voltage imaging—increased noise from reduced photon flux—was effectively mitigated by iDose4 iterative reconstruction (level 4), consistent with the broader principle that advanced reconstruction algorithms substantially reduce image noise while preserving spatial resolution [15]. The large pitch of 1.007 enabled 55% scan time reduction, which is particularly advantageous in emergency settings where haemodynamically unstable patients may have limited breath-hold capacity [13].

The most substantial image quality improvement was the twelve-fold reduction in aortic root motion artefacts (from 90.0% to 7.5%), attributable to prospective ECG-gated acquisition centred at 45% of the R-R interval [16]. Our dual-phase approach mitigates the dose limitation of ECG-gating by restricting gated acquisition to the aortic root whilst acquiring the remainder of the thoracoabdominal aorta with the rapid large-pitch technique. This targeted approach ensures motion-free imaging of the most diagnostically critical region without imposing the full dose penalty of ECG-gated whole-aorta scanning.

The observed differences between protocols may, in part, reflect temporal evolution in imaging practice at our institution, as the experimental protocol was implemented following the installation and clinical validation of the 256-slice CT platform. Even so, the magnitude of improvement across all measured parameters—particularly the near-complete elimination of aortic root motion artefacts—is unlikely to be attributable solely to incremental technological improvements unrelated to the protocol design.

## 4.3 Clinical Implications

The diagnostic accuracy for Stanford Type A dissection is among the most clinically significant findings in this cohort. The experimental protocol achieved 100% accuracy (26 of 26 cases) compared with 80% (20 of 26) for the conventional protocol. Stanford Type A dissection is a surgical emergency with mortality increasing by approximately 1–2% per hour without intervention [1]; misclassification may lead to inappropriate conservative management with catastrophic consequences. The GRRAS study [8] previously reported inferior diagnostic performance of non-ECG-gated CTA for ascending aortic dissection, and Shnayien et al. [17] demonstrated that high-pitch non-gated acquisitions suffered from motion artefacts compromising accuracy. The present findings are consistent with these prior reports and support the hypothesis that targeted prospective ECG-gating eliminates the root cause of these diagnostic failures.

Clear visualisation of the primary entry tear is essential for preoperative surgical planning, since tear location determines the proximal extent of ascending aortic replacement [6]. The experimental protocol achieved 95.83% clear visualisation (23 of 24 patients) versus 60.00% (15 of 25 patients), providing surgeons with precise anatomical information regarding tear location and relationship to the aortic valve commissures and coronary ostia [18]. The 55% scan time reduction also implies lower contrast medium requirements, potentially reducing contrast-induced nephropathy risk in patients with pre-existing renal impairment.

These findings, derived from retrospective analysis of consecutive cases with propensity score-matched historical controls, provide clinically relevant guidance for protocol selection in emergency aortic imaging. Although the non-randomised design limits the strength of causal inference, the magnitude and consistency of observed differences across all measured endpoints support preferential use of the dual-phase 100 kVp ECG-gated protocol when this capability is available. From a service delivery perspective, the 55% reduction in scan time offers the additional benefit of improved scanner throughput in busy emergency departments, where timely diagnosis is critical for patient outcomes.

## 4.4 Comparison with Alternative Approaches

High-pitch CT offers an alternative approach, with modern systems covering the entire aorta in less than 2 seconds [13]. However, dual-source CT is not universally available, and rapid scan speed alone may not eliminate cardiac motion artefacts in patients with elevated heart rates. Dual-energy CT enables material decomposition and iodine mapping but typically requires higher radiation doses and is limited to specialised platforms. Photon-counting detector CT is an emerging technology with improved energy resolution and enhanced iodine CNR [19]; recent studies have demonstrated its capacity to enable aortic CTA with reduced contrast media volume [20]. However, current photon-counting systems remain limited to specialised centres, whereas our low-kV single-energy approach achieves substantial dose reduction on widely available hardware, making it more readily implementable across diverse clinical settings.

Our retrospective design with historical controls mirrors the methodology employed in several prior investigations of novel CTA protocols. Wong et al. [16] used a similar before-and-after comparison to evaluate ECG-triggered versus non-ECG-triggered aortic imaging, and Budeanu et al. [8] employed

consecutive non-randomised cohorts in the GRRAS study comparing ECG-gated and non-gated CTA for ascending aortic dissection. Our use of propensity score matching represents a methodological advance over these earlier studies, as it addresses the selection bias inherent in retrospective comparisons by systematically balancing observed confounders between groups. The consistency of our findings with those of prospectively designed studies nonetheless strengthens confidence in the clinical validity of the observed improvements.

## 4.5 Limitations

This study has several limitations that should be considered when interpreting the findings.

**Retrospective design and selection bias.** Most importantly, the retrospective non-randomised design with historical controls introduces the possibility of selection bias and confounding. Patients were not randomly assigned to the experimental or control protocol; rather, group allocation was determined by the CTA protocol in use at the time of their presentation. Although we employed propensity score matching to balance observed baseline characteristics between the two cohorts, this technique cannot account for unmeasured confounding variables. Temporal trends in referral patterns, evolution in clinical decision-making thresholds, subtle shifts in patient demographics over the study period, and changes in the threshold for surgical intervention may have influenced the observed differences between groups. Residual confounding from unmeasured or unmeasurable factors cannot be excluded, and the observed associations should not be interpreted as establishing definitive causal relationships.

**Temporal confounding.** Second, the historical control design introduces temporal confounding as an important source of bias. The control group was drawn from an earlier time period (January to June 2024) than the experimental group (July 2024 to December 2025). During this interval, multiple aspects of clinical practice may have evolved, including radiologist experience with CTA interpretation, refinements in contrast administration technique, changes in patient preparation protocols, and incremental improvements in CT scanner performance or reconstruction algorithms. The learning curve associated with adoption of the new low-kV protocol may have favoured the experimental group independently of any intrinsic protocol advantages. We attempted to minimise this effect by ensuring that both groups were scanned on the same CT platform by identical technologist teams; nevertheless, subtle temporal effects cannot be eliminated entirely in a before-and-after study design.

**Data completeness and information bias.** Third, the study relied on the completeness and accuracy of data extracted retrospectively from electronic medical records and the PACS. Certain potentially relevant clinical variables—including detailed haemodynamic parameters at the time of presentation, cumulative contrast medium exposure from prior imaging studies, precise timing of intervention, and comprehensive medication histories—were not consistently documented across all patient records and could not be incorporated into the propensity score model or comparative analyses. Missing or incomplete data in a subset of patient records may have introduced information bias, particularly if the completeness of documentation differed systematically between the early and late study periods.

**Single-centre setting and generalisability.** Fourth, this was a single-centre study at a tertiary cardiovascular referral hospital in China. The patient population, clinical workflows, emergency triage practices, and local expertise at our institution may not be representative of other centres or geographic regions. This relatively homogeneous patient cohort limits the generalisability of findings to more diverse populations, including those with different ethnic backgrounds, body habitus distributions, and prevalence of comorbid cardiovascular disease.

**Sample size considerations.** Fifth, the study included 80 patients with 40 in each group after propensity score matching. Although this sample size was adequate to detect large differences in objective parameters such as radiation dose, scan time, and motion artefact rates, it may have been underpowered to detect smaller but clinically meaningful differences in secondary outcomes. The relatively small number of patients with Stanford Type A dissection (26 in the experimental group, 20 in the control group) further limits the precision of diagnostic accuracy estimates.

**Exclusion of challenging subgroups.** Sixth, patients with severe arrhythmias, very high heart rates (> 90 bpm), or BMI > 30 kg/m<sup>2</sup> were not included in either group; the feasibility and diagnostic performance of 100 kVp imaging in these more challenging populations remains uncertain and warrants dedicated investigation.

**Observer blinding.** Seventh, although the interpreting radiologists were blinded to clinical information, complete blinding to the scanning protocol was not possible given the visible differences in image characteristics between the two techniques. This may have introduced observer bias in subjective image quality scoring, despite the use of standardised grading criteria.

**Absence of long-term outcome data.** Eighth, the study lacked long-term clinical outcome data. Although diagnostic accuracy and image quality parameters were comprehensively evaluated, the impact of protocol selection on patient management decisions, surgical planning efficiency, and ultimately clinical outcomes—including mortality, reoperation rates, length of hospital stay, and postoperative complications—could not be assessed from the retrospective data.

**Causal inference.** Ninth, the non-randomised retrospective design precludes definitive causal inference. Although the observed associations between the dual-phase 100 kVp protocol and improved outcomes are biologically plausible and consistent across multiple metrics, we cannot exclude the possibility that unmeasured confounding or temporal trends contributed to the observed differences. Prospective comparative studies or, ideally, randomised controlled trials would be needed to confirm the causal relationship between protocol selection and the reported improvements.

## 4.6 Future Directions

Multi-centre validation with larger cohorts is needed to confirm protocol reproducibility across different CT platforms and clinical settings. Such studies should ideally employ prospective designs with randomised allocation to overcome the limitations of retrospective historical control comparisons. Integrating deep learning reconstruction (DLR) algorithms may enable further dose reduction beyond

that achieved with iDose4; recent investigations have demonstrated that DLR facilitates ultra-low-dose aortic CTA at 60 kVp with reduced contrast medium volume whilst maintaining diagnostic image quality [9]. Automated tube voltage selection systems may further optimise the dose–quality balance. The dual-phase approach could also be extended to other aortic pathologies requiring precise aortic root evaluation, including transcatheter aortic valve replacement planning and heritable thoracic aortic disease surveillance [21]. Future prospective comparative studies incorporating blinding of outcome assessors, standardised clinical follow-up, and rigorous randomisation would strengthen the evidence base supporting protocol selection in emergency aortic imaging.

## 5. Conclusions

In this single-centre retrospective comparative study with propensity score-matched historical controls, the dual-phase 100 kV aortic CTA protocol with prospective ECG-gating was consistently associated with superior performance across multiple metrics compared with conventional 120 kV non-ECG-gated CTA. The experimental protocol addressed both challenges of aortic root motion artefacts and excessive radiation dose, reducing effective dose by 48%, reducing scan time by 55%, virtually eliminating root motion artefacts, and achieving 100% diagnostic accuracy for Stanford Type A dissection on widely available 256-slice CT platforms. Although the retrospective non-randomised design with historical controls limits the strength of causal inference and introduces the possibility of unmeasured confounding, the magnitude and consistency of observed improvements across independent measures of image quality, radiation exposure, and diagnostic performance provide strong supportive evidence for the clinical value of this optimised approach. The protocol aligns with the ALARA principle and should be considered a preferred technique for CTA evaluation of suspected aortic dissection, particularly when accurate aortic root assessment is required. These findings warrant confirmation in prospective multi-centre studies with randomised designs.

## Declarations

**Ethics approval and consent to participate:** This retrospective study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Tianjin Chest Hospital (approval number: 2024-LW-036; date of approval: 15 December 2024). The requirement for individual patient informed consent was waived by the Institutional Review Board owing to the retrospective nature of the study and the use of anonymised data.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions relating to patient medical information.

**Competing interests:** The authors declare no competing interests.

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**Authors' contributions:** Conceptualisation, Y.C. and J.S.; methodology, M.H.; software, M.H.; validation, B.L. and J.S.; formal analysis, Y.C.; investigation, H.Z.; resources, H.Z.; data curation, B.L.; writing–original draft preparation, all authors; writing–review and editing, H.Z.; visualisation, Y.C.; supervision, H.Z.; project administration, H.Z. All authors have read and approved the final manuscript.

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## Figures

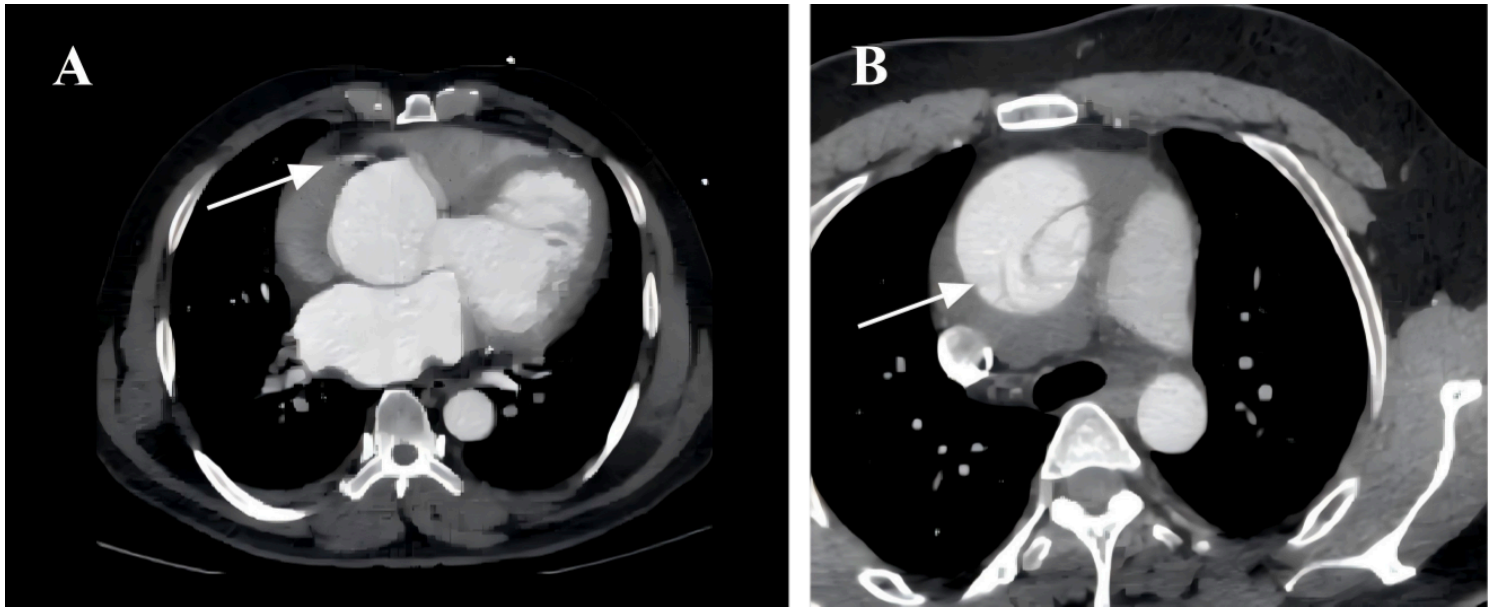


**Figure 1**

Representative images from the non-ECG-gated single-phase CT scanning protocol (control group). **(A)** A patient who presented with acute chest pain. Marked pulsation artefact is visible at the aortic root (white arrow). **(B)** A patient who presented with severe tearing chest pain. Non-ECG-gated aortic CTA demonstrates ascending aortic dissection; however, the intimal entry tear is poorly visualised owing to pulsation artefacts (white arrow).

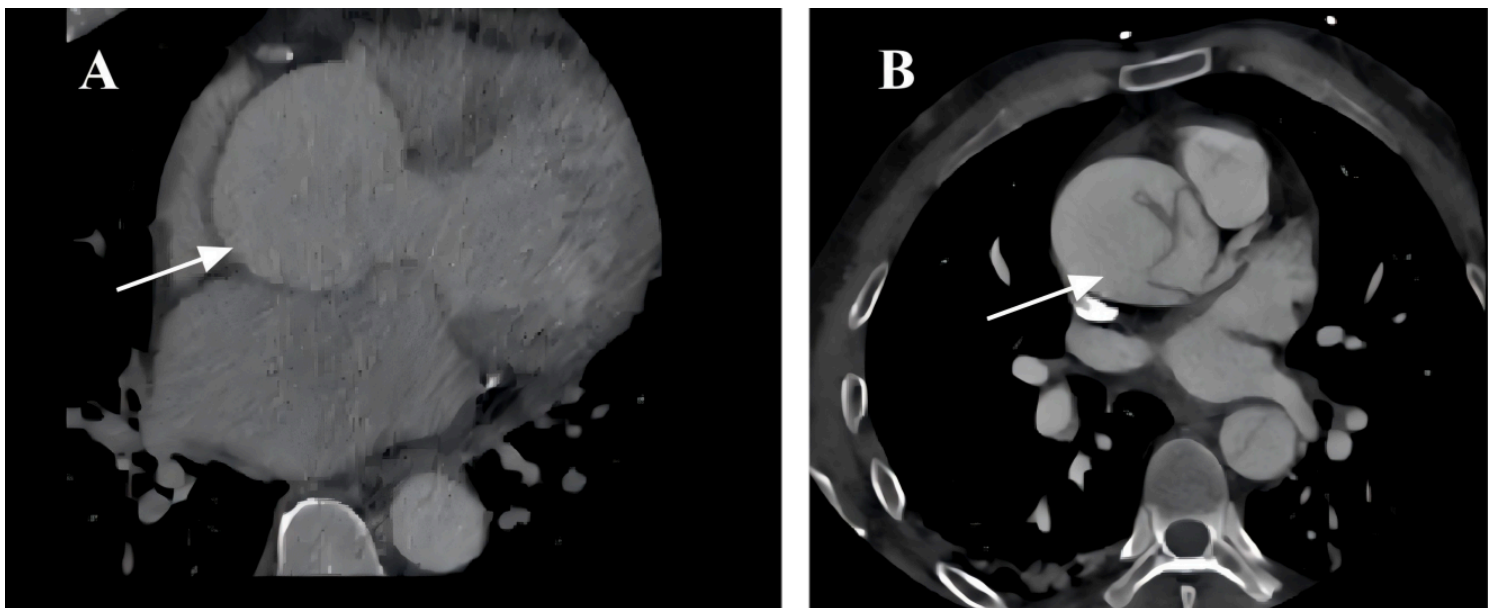


**Figure 2**

Representative images from the ECG-gated dual-phase CT scanning protocol (study group). **(A)** A patient who presented with persistent chest pain. The ascending aortic root is depicted clearly without pulsation artefacts (white arrow). **(B)** A patient who presented to the emergency department with acute chest pain and profuse sweating. Aortic CTA demonstrates Stanford type A aortic dissection. Using the ECG-gated

dual-phase protocol, the entry tear and intimal flap at the ascending aortic root are clearly visualised (white arrow).