# Use of Multi-Modality Technology to Reduce the Radiation Dose of Multi-Slice Spiral CT Coronary Angiography (MSCTCA) in Normal Weight and Overweight Patients

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**Research Article**

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# Abstract

**Purpose:** This study was performed to explore the value of multi-modality technology, with a combination of narrow acquisition window, isocentric scanning, low tube voltage, low tube current and iterative reconstruction (IR), for reducing the radiation dose in multi-slice spiral computed tomography coronary angiography (MSCTCA).

**Materials and methods:** In this prospective randomised controlled study, 154 patients with coronary heart disease (CHD) were classified according to body mass index (BMI) as normal weight (BMI 18–27kg/m$^{2)}$ or overweight (BMI ≥ 27 kg/m$^2$), and divided into four groups: multi-modality–normal BMI group ($A_1$, *n* = 82); multi-modality–overweight group ($B_1$, *n* = 17); conventional–normal BMI group ($A_2$, *n* = 39); and conventional–overweight group ($B_2$, *n* = 16). The parameters in the multi-modality groups were as follows: isocentric scan, tube voltage = 80 kV, tube current control using 80% "smart milliampere", and maximum current during 60–80% of the RR interval. The parameters in the conventional groups were as follows: normal position, tube voltage = 100 kV, tube current control using smart milliampere, and maximum current during 30–80% of the RR interval. The effective radiation dose (ED), objective image quality (IQ), noise, signal-to-noise ratio (SNR), contrast signal-to-noise ratio (CNR) and subjective 5-point Likert scale IQ scores of MSCTCA images were compared among the four groups.

**Results:** The average EDs of groups $A_1$, $A_2$, $B_1$and $B_2$ were( 1.13±0.35 ) mSv, ( 3.36±1.30 ) mSv, ( 1.54±0.53 ) mSv and ( 5.90±0.93 ) mSv, respectively. There were statistically significant differences in ED between groups $A_1$ and $A_2$, and between groups $B_1$ and $B_2$ (all $P < 0.01$). Noise was significantly lower, and both SNR and CNR were significantly higher, in group $A_2$ than group $A_1$ (all $P < 0.01$), but there were no significant differences in these parameters between groups $B_1$ and $B_2$ ($P$ = 0.14–0.51). The average IQ scores of groups $A_1$, $A_2$, $B_1$and $B_2$ were 4.46±0.59(Fig.3), 4.45±0.62(Fig.4), 4.39±0.68(Fig.5) and 4.42±0.66(Fig.6),respectively. There were no significant differences in subjective IQ scores among the four groups ($P$ = 0.12). Consistency among observers in the subjective IQ scores of the four groups was very good, with intraclass correlation coefficients (ICCs) of 0.71–0.90. The subjective IQ scores of the coronary artery were excellent in all four groups, with a total good-to-excellent rate of ≥ 92.64%, and the total number of evaluable segments in the images of all four groups was ≥ 98.26%.

**Conclusions:** Under conditions appropriate for clinical diagnosis, multi-modality technology can reduce the radiation dose of MSCTCA scans in both normal weight and overweight patients.

# 1 Introduction

Multi-slice spiral computed tomography coronary angiography (MSCTCA) is the preferred non-invasive examination method for coronary heart disease (CHD) [1]. There has been a great deal of technological progress in MSCTCA over the past two decades. Due to its high accuracy for detecting moderate to severe coronary artery stenosis, MSCTCA has replaced traditional invasive coronary angiography for patients with suspected CHD. With the popularisation of computed tomography (CT), more patients have been undergoing these scans, with a reported 300% increase in scans in the USA, from USA scans people in 1993 to 71.7 million people in 2007. According to data collected in the USA between 1991 and 1996, malignant tumours caused by CT radiation accounted for 0.4% of all malignant tumours. MSCTCA has the drawback of a higher radiation dose than other types of CT, and radiation from CT has become the focus of attention as public awareness of radiation hazards continues to increase [5].

With advances in computer technology, a number of measures have been developed to reduce radiation dose, such as prospective electrocardiography (ECG) gating, iterative reconstruction (IR), personalised scanning, and "smart milliampere" [5, 6]. With the advent of high-end CT machines, low tube voltage scanning has been used in MSCTCA

[1, 7, 8]. Methods for further reducing the radiation dose of MSCTCA are urgently required. A few groups have reported use of dual-source CT (Siemens Healthcare, Malvern, PA, USA) and GEMS CT (GE Medical Systems, Milwaukee, WI, USA) to reduce the tube voltage to 80 kV and control the tube current using smart milliampere, thus significantly reducing the effective radiation dose (ED) [9–11].

**Principle of isocentric scanning**

In CT, the projection of the beam is defined in the centre of the CT frame. The beam in multi-slice spiral CT is conical. A spherical tube and detector scanning movement frame hole centre position to accept more rays, thus improving objective image quality (IQ). Isocentric scanning refers to the case where the scanning part is consistent with the empty centre of the gantry. This technology is widely used for all types of CT. Application of this technology to CT can also reduce the ED of CT scans of off-centre organs [12] (Fig. 1).

**IR technology**

In comparison with filtered back projection (FBP)-based image reconstruction methods, IR methods show less image noise and fewer artefacts, while also reducing ED [13]. Several IR methods are available from major vendors, including adaptive iterative dose reduction (AIDR3D) and forward-projected model-based IR (Canon Medical Systems, Otawara, Japan) [14].

In this study, we used a narrow acquisition window, low tube voltage, low tube current and isocentric scanning (multi-modality technology) or conventional MSCTCA in patients with suspected CHD, classified according to body mass index (BMI) as normal weight (BMI 18–27kg/m$^2$) or overweight (BMI ≥ 27 kg/m$^2$). After scanning, AIDR3D was used to reconstruct images and compare the results between the conventional and multi-modality methods. The IQ and ED were compared between the two scanning methods, to explore the feasibility of multi-modality technology for reducing the radiation dose in MSCTCA.

## 2 Materials And Methods

# 2.1 Study population

This study was approved by the institutional review board of ---, and all patients provided written informed consent. Between November 2020 and August 2021, all consecutive patients with clinically suspected CHD were screened for inclusion in the study. The inclusion criteria were as follows: age ≥ 18 years, heart rate < 70 bpm and BMI ≥ 18 kg/m$^2$. We excluded patients with pacemakers, severe respiratory artefacts, metal implants within the scanning range, allergies to contrast media or betaloc, or a history of cardiac tumours or cardiac surgery.

The study population consisted of 154 patients with CHD, classified according to BMI as described above and divided into four groups: multi-modality–normal BMI group ($A_1$, $n$ = 82); multi-modality–overweight group ($B_1$, $n$ = 17); conventional–normal BMI group ($A_2$, $n$ = 39); and conventional–overweight group ($B_2$, $n$ = 16).

# 2.2 MSCTA examination

MSCTA examinations were performed using a Toshiba 320-row dynamic CT system (Aquilion ONE; Canon Medical Systems). Prospective ECG gating was used to reduce the radiation dose [15]. The scanning range extended 140 mm upwards starting from the lower edge of the heart. In groups $A_1$ and $B_1$, isocentric scans were performed with the patient lying on their back with the body shifted to the right. Before the MSCTCA scans, ultrasound examination was performed to mark the leftmost and rightmost edges of the heart on the body surface, and perpendicular lines were made along the leftmost and rightmost edges of the heart. The centreline of the two vertical lines was used as the vertical positioning line and the horizontal axillary centreline was used as the horizontal positioning line, with the maximum current during 60–80% of the RR interval. Groups $A_2$ and $B_2$ were scanned using the conventional method, with the patient in the natural supine position. The horizontal axillary centreline was again used as the horizontal positioning and the median line was used as the vertical positioning line, with the maximum current during 30–80% of the RR interval. The scanning parameters were as follows: groups $A_1$ and $B_1$, tube voltage = 80 kV, 80% tube current control to 80% using smart milliampere (done automatically by the Toshiba instrument according to body position); groups $A_2$ and $B_2$, tube voltage = 100 kV, tube current control using milliampere. Previous studies showed no difference in IQ between a tube voltage of 80 kV and injection rate of 4.0 ml/s versus a tube voltage of 100 kV and injection rate 5.0 ml/s [1,9,16]. Iodine contrast agent (Ultravist; 370 mg I/ml) was injected as a single bolus via the elbow vein in a volume of 30–50 ml at an injection rate of 4.0 ml/s, followed by 18 ml of saline in groups $A_1$ and $B_1$. In groups $A_2$ and $B_2$, the volume was 50–70 ml at an injection rate of 5.0 ml/s, again followed by 18 ml of saline. The bolus injection tracing method was used and the threshold was set to 280 HU (Table 2).

## 2.3 Preparation before scanning

All patients provided written informed consent to participate in the study. Heart rate and blood pressure were measured at rest, before the examination. Patients with a heart rate > 70 bpm were given betaloc (25–100 mg). Patients with a BMI ranging from 18 kg/m$^2$ to 27kg/m$^2$ were randomly assigned in a 2:1 ratio to groups $A_1$ and $A_2$, and patients with a BMI ≥ 27 kg/m$^2$ were randomly assigned in a 1:1 ratio to groups $B_1$ and $B_2$. Before the examination, patients were given a 0.5 mg nitroglycerine tablet.

## 2.4 Radiation dose

The CT dose index volume (CTDIvol; mGy) and dose length product (DLP; mGy × cm) were automatically calculated for all CT protocols by the scanner software. DLP was then multiplied by a conversion coefficient, *k*, to determine the effective dose (ED = DLP × *k*) for each patient [16] (Table 1).

## 2.5 Image processing and analysis

All images were reconstructed with adaptive AIDR 3D. The scanning parameters were as follows: scan length, 140 mm; slice thickness, 0.5 mm; reconstruction field of view, 220 mm; and kernel, EU10 (Table 2).

## 2.6 Subjective and objective evaluation of image quality

The objective IQ was evaluated by two experienced cardiovascular radiologists (MQ Xiao, 17 years of experience, and PK Huang, 13 years of experience) who were blinded to the scan and reconstruction parameters. A circular region of interest (ROI) with a diameter of 1 cm was placed within the cortical part of the main bronchus. The coronary artery attenuation values of the proximal ROIs of the left main coronary artery (LMCA) and the right coronary artery (RCA) were measured. The ROI was as large as possible, and the vascular wall, vascular calcifications, and non-calcified plaques and artefacts were excluded. The average coronary artery attenuation was equal to the average value of the

LMCA and proximal RCA [1, 17]. ROI measurement was performed on the adjacent myocardial fat. The ROI measurements were repeated three times at each location and averaged to ensure data consistency. The CT value, standard deviation (SD) of the main bronchus and average attenuation values of the coronary artery and pericardial fat were calculated by averaging the values obtained by the two observers. Noise was calculated as the SD of the CT value of the main bronchus. The signal-to-noise ratio (SNR) and contrast signal-to-noise ratio (CNR) were calculated as follows: SNR = average main bronchus CT value/image noise; CNR = (average attenuation of coronary artery − perivascular fat attenuation)/image noise [12].

Coronary artery segmentation was performed according to the 15-segment coronary artery segmentation method developed by the American Heart Association [1, 17]. Two radiologists with 18 years (MQ Xiao) and 13 years (PK Huang) of experience in cardiovascular medicine conducted independent evaluations of coronary arteries with diameter ≥ 1.5 mm. In the event of inter-rater disagreement, a consensus was reached through consultation. A 5-point Likert scale was used, as follows [18, 19]: 5 = excellent (sharp, smooth contours of the vascular wall and no streaking or radiating artefacts); 4 = good (slight irregularities of the contour and few streaks or radiating artefacts); 3 = fair (blurred and irregular contour of the vascular wall and numerous streaks or radiating artefacts); 2 = poor (deformation of the vascular wall and many artefacts); 1 = very poor (obvious deformation of the vascular wall and extensive artefacts). Images with IQ scores of 3–5 satisfied the requirements for diagnostic assessments (Fig. 2).

## 2.7 Statistical analysis

Statistical analyses were performed using SPSS 26.0 software (IBM Corp., Chicago, IL, USA). Continuous variables are expressed as the mean ± SD. The *t* test was used for pairwise comparisons between groups. The Chi-square test was used for analyses based on sex. The intraclass correlation coefficient (ICC) was calculated to determine the consistency of the subjective IQ scores. An ICC > 0.70 indicated adequate test–retest reliability [20]. In all analyses, $P < 0.05$ was taken to indicate statistical significance.

# 3 Results

The study population consisted of 154 patients (95 men and 59 women) aged 37–87 years (mean ± SD, 60.05 ± 10.90 years).

The patients were divided into group $A_1$ ($n$ = 82), group $A_2$ ($n$ = 39), group $B_1$ ($n$ = 17) and group $B_2$ ($n$ = 16). There were no significant differences in sex, age or BMI among the groups ($P$ = 0.06–0.43; see Table 1).

The average EDs of groups $A_1$, $A_2$, $B_1$and $B_2$ were( 1.13 ± 0.35 ) mSv, ( 3.36 ± 1.30 ) mSv, ( 1.54 ± 0.53 ) mSv and ( 5.90 ± 0.93 ) mSv, respectively. There were statistically significant differences in ED between groups $A_1$ and $A_2$, and between groups $B_1$ and $B_2$ (all $P < 0.01$). The average noise was significantly lower, and both SNR and CNR were significantly higher, in group $A_2$ than group $A_1$ (all $P < 0.01$), but there were no significant differences in these parameters between groups $B_1$ and $B_2$ ($P$ = 0.14–0.51) (Table 1). The CT values of the ascending aorta root, LMCA and RCA root were significantly higher in in groups $A_1$ and $B_1$ compared to groups $A_2$ and $B_2$, respectively ($P < 0.05$).

In total, there were 2,085 potentially evaluable segments. Due to the diameter being < 1.5 mm, or to occlusion, 82 segments in the 100 kV group and 143 in the 80 kV group were considered non-evaluable. The statistics of the coronary artery segments in groups $A_1$, $B_1$, $A_2$ and $B_2$ groups are shown in Table 2. The average IQ scores of groups $A_1$, $A_2$, $B_1$and $B_2$ were 4.46 ± 0.59, 4.45 ± 0.62,4.39 ± 0.68 and 4.42 ± 0.66, respectively. There were no significant differences in IQ scores in groups A1 and A2 in groups B1 and B2 (P = 0.08–0.31). The consistency in subjective IQ scores among the observers for the four groups was considered very good (ICCs = 0.71–0.90).

## 4 Discussion

In this study, multi-modality technology was used to reduce the radiation dose of MSCTCA. The average radiation doses of groups $A_1$, $A_2$, $B_1$and $B_2$ were ( 1.13 ± 0.35 ) mSv, ( 3.36 ± 1.30 ) mSv,( 1.54 ± 0.53 ) mSv and ( 5.90 ± 0.93 ) mSv, respectively. There were no significant differences in subjective IQ scores among the four groups ($P$ = 0.12). Interestingly, low-dose MSCTCA with a Toshiba 640-slice CT scanner, in patients with a heart rate < 70 bpm, had a mean ED of 2.67 ± 0.5 mSv [17]. Similarly, Di Cesare, E [18] and Li et al. [10] reported median EDs of 2.80 ± 0.57 mSv and 3.36 ± 2.35 mSv, respectively. The latter value was equivalent to group $A_2$ in this study.

The objective IQ scores (noise, SNR, CNR) were better in group $A_2$ than group $A_1$, but there were no differences in subjective IQ scores between the two groups. There were no differences in objective IQ scores (noise, SNR, CNR) or subjective IQ scores between groups $B_1$ and $B_2$. In this study, a total of 2,085 coronary artery segments were evaluated. The IQ was classified as excellent or good in 1,836 segments(Fig. 3–6), accounting for 94.96% of the total. The total good-to-excellent rate of group A2 was high (92.64%), and the total number of evaluable segments in the four groups of images was ≥ 98.26%. The average subjective IQ scores of groups $A_1$, $A_2$, $B_1$ and $B_2$ were4.46 ± 0.59, 4.45 ± 0.62,4.39 ± 0.68 and 4.42 ± 0.66, respectively, and there were no significant differences among the four groups ($P$ > 0.05).

This study showed that the radiation dose of MSCTCA was significantly reduced by application of the multi-modality technique. The radiation doses in patients with a normal BMI in groups $A_1$ and $A_2$, and of overweight patients in groups $B_1$ and $B_2$, were about 33.63% and 26.10% of the dose associated with the conventional method, respectively. Some groups reported a significant reduction of ED by low-dose MSCTCA using dual-source CT (Siemens Healthcare) [10, 16], GEMS CT (GE Medical Systems) [9], and Philips Brilliance 256-slice iCT (Philips Medical Systems) [6] with a tube voltage of 80 kV, this is the first report of low-dose MSCTCA with a tube voltage of 80 kV using a Toshiba CT system. Our group previously reported a 15% reduction in radiation dose using isocentric scanning compared to conventional MSCTCA [12]. Khosa et al. [21] performed MSCTCA using a Toshiba 320-row dynamic CT system (Aquilion ONE; Toshiba Medical Systems) with a tube voltage of 120 kV and maximum current during 66–80% of the RR interval. The radiation dose of the former study was about 67% that of the latter, for a BMI of 28.7 kg/$m^2$ and ED of up to 6.33 mSv. Some groups reported radiation doses as high as 1.76 ± 0.43–2.72 ± 0.50 mSv using MSCTCA with a tube voltage of 80 kV [9, 10, 16].

Multi-modality technology can significantly reduce the MSCTCA radiation dose under conditions necessary for clinical diagnosis. While reducing the tube voltage, the contrast medium injection time remained the same, and the contrast medium dosage was reduced by 20% from 5.0 to 4.0 ml/s. The CT value of the arterial root was higher in the multi-modal than conventional group.

Previous studies have shown that a low tube voltage can reduce the radiation dose, but this is accompanied by increased image noise and decreased CNR, such that the radiation dose reduction is limited. X-ray intensity is positively correlated with the square of the tube current and tube voltage: X-ray intensity: $I = KiZU^2$( I : X-ray intensity. i : tube current. K : Proportion factor. Z : anode atomic number of target material. U : tube voltage ). Therefore, reducing the tube voltage can significantly reduce the radiation dose compared to reducing the tube current.

Adaptive AIDR3D, which was used here to reconstruct images and compare the results between the conventional and multi-modality methods, has been shown to effectively improve the IQ and reduce the radiation dose in scans of different areas [17, 18, 23–25]. Ultra-low-dose CT with AIDR3D was shown to significantly improve IQ [24].

This study had some limitations. First, all patients had a heart rate < 70 bpm and patients with a low BMI were excluded. Also, the IQ of the coronary arteries was scored only subjectively and there was no comparison between MSCTCA and digital subtraction angiography (DSA) of the coronary arteries. In addition, the study population included relatively few overweight patients (BMI ≥ 27). Further detailed studies are required in populations classified according to obesity grade (grade 1, BMI = 27.5–32.5kg/$m^2$; grade 2, BMI = 32.5–37.5 kg/$m^2$; grade 3, BMI ≥ 37.5 kg/$m^2$) [25].

In conclusion, multi-modality MSCTCA significantly reduced the radiation dose under conditions meeting the requirements for clinical diagnosis in both normal weight (BMI = 18–27 kg/$m^2$) and overweight patients (BMI ≥ 27.0 kg/$m^2$).

# Declarations

### Ethics Statement

This study was approved by the institutional review board of ––, and all patients provided written informed consent.

### Consent for publication

Written informed consent for publication was obtained from all participants.

### Availability of data and material

The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

### Competing Interests

The authors declare that they have no competing interests.

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### Authors' contributions

Xiaolu Hu and Peikai Huang contributed equally to the present study. All authors read and approved the final manuscript.

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# Tables

Table 1. Characteristics of the four groups

| Group (*n*) | Sex (F/M) | Age (y) | BMI ( kg/m2) | CTDvol（mGy) | DLP( mGy ×cm) | ED（mSv） |
|---|---|---|---|---|---|---|
| $A_1$(n=82) | 31/51 | 59.59±9.66 | 23.06±1.95 | 5.89±1.85 | 80.58±24.80 | 1.13±0.36 |
| $A_2$(n=36) | 19/20 | 64.15±13.28 | 22.58±1.96 | 17.92±8.02 | 250.90±112.25 | 3.36±1.30 |
| P | 0.43 | 0.17 | 0.06 | 0.001 | 0.001 | 0.001 |
| $B_1$(n=17) | 6/11 | 58.53±8.40 | 27.98±0.91 | 7.86±2.72 | 110.21±37.99 | 1.54±0.53 |
| $B_2$(n=16) | 3/13 | 54.00±10.00 | 28.73±1.25 | 30.07±4.72 | 421.31±66.07 | 5.90±0.93 |
| p | 0.43 | 0.17 | 0.06 | 0.001 | 0.001 | 0.001 |

Table 2. CT Parameters of the conventional and multi-modality treatment groups

| Dose group | Conventional group | Multi-modality group |
|---|---|---|
| Tube voltage (kV) | 100 | 80 |
| Tube current (mA) | smart milliampere | 80% smart milliampere |
| D-FOV（mm） | 220 | 220 |
| Rotation time (s) | 0.275 | 0.275 |
| Thickness (mm) | 0.5 | 0.5 |
| Interval (mm) | 0.5 | 0.5 |
| AIRD3D | Standard EU10 | Standard EU10 |
| Scanning method | ECG gating | ECG gating |
| Cardiac cycle | 30–80% | 60–80% |
| Scan position | conventional | isocentric |
| Scan length | 140mm | 140mm |

Table 3. CT values and objective IQ scores of the aortic roots and proximal coronary vessels

| Group (*n*) | Aortic root (HU) | LAD（HU） | RCA（HU） | Noise | SNR | CNR |
|---|---|---|---|---|---|---|
| $A_1$(n=82) | 512.18±108.22 | 477.20±117.93 | 485.88±4100.40 | 15.52±4.73 | 66.00±25.30 | 41.32±16.13 |
| $A_2$(n=39) | 601.92±125.34 | 534.67±117.33 | 546.99±109.30 | 13.77±4.23 | 80.51±41.08 | 51.89±22.72 |
| P | 0.07 | 0.32 | 0.37 | 0.51 | 0.14 | 0.25 |
| $B_1$(n=17) | 579.52±100.26 | 513.62±86.90 | 514.43±75.89 | 18.75±4.36 | 54.64±14.66 | 35.34±13.38 |
| $B_2$(n=16) | 661.39±121.83 | 558.84±114.02 | 586.10±100.56 | 19.29±6.26 | 54.28±17.72 | 38.45±12.06 |
| P | 0.02 | 0.28 | 0.06 | 0.001 | 0.001 | 0.001 |

Table 4. Subjective IQ scores and number of score segments in the four groups

| Group | All segments | 5 | 4 | 3 | 2 | 1 | Average IQ score |
|---|---|---|---|---|---|---|---|
| $A_1$ | 1085 | 420（38.71%） | 611（56.48%） | 45（4.15%） | 6（0.55%） | 1（0.09%） | 4.46±0.59 |
| $A_2$ | 518 | 258（49.81%） | 232（44.79%） | 19（3.67%） | 8（1.54%） | 1（0.19%） | 4.45±0.62 |
| $B_1$ | 231 | 135（58.44） | 79（34.20%） | 13（5.63%） | 4（1.73%） | 0 | 4.39±0.68 |
| $B_2$ | 224 | 97（43.30%） | 119（53.13%） | 6（2.68%） | 2（0.89%） | 0 | 4.42±0.66 |
| P | | | | | | | 0.12 |

# Figures

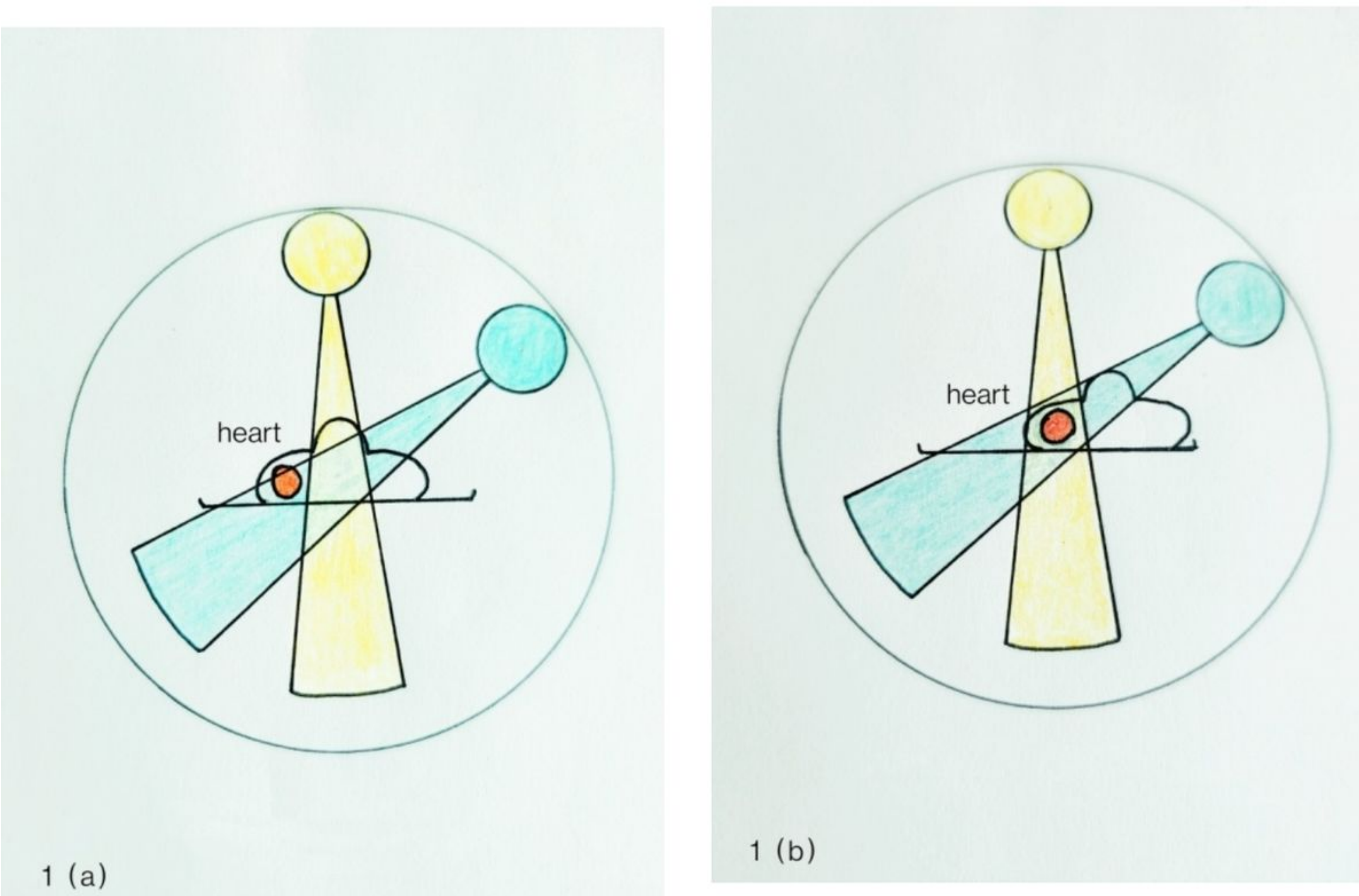



**Figure 1**

(a) Conventional position. (b) Isocentric scanning.

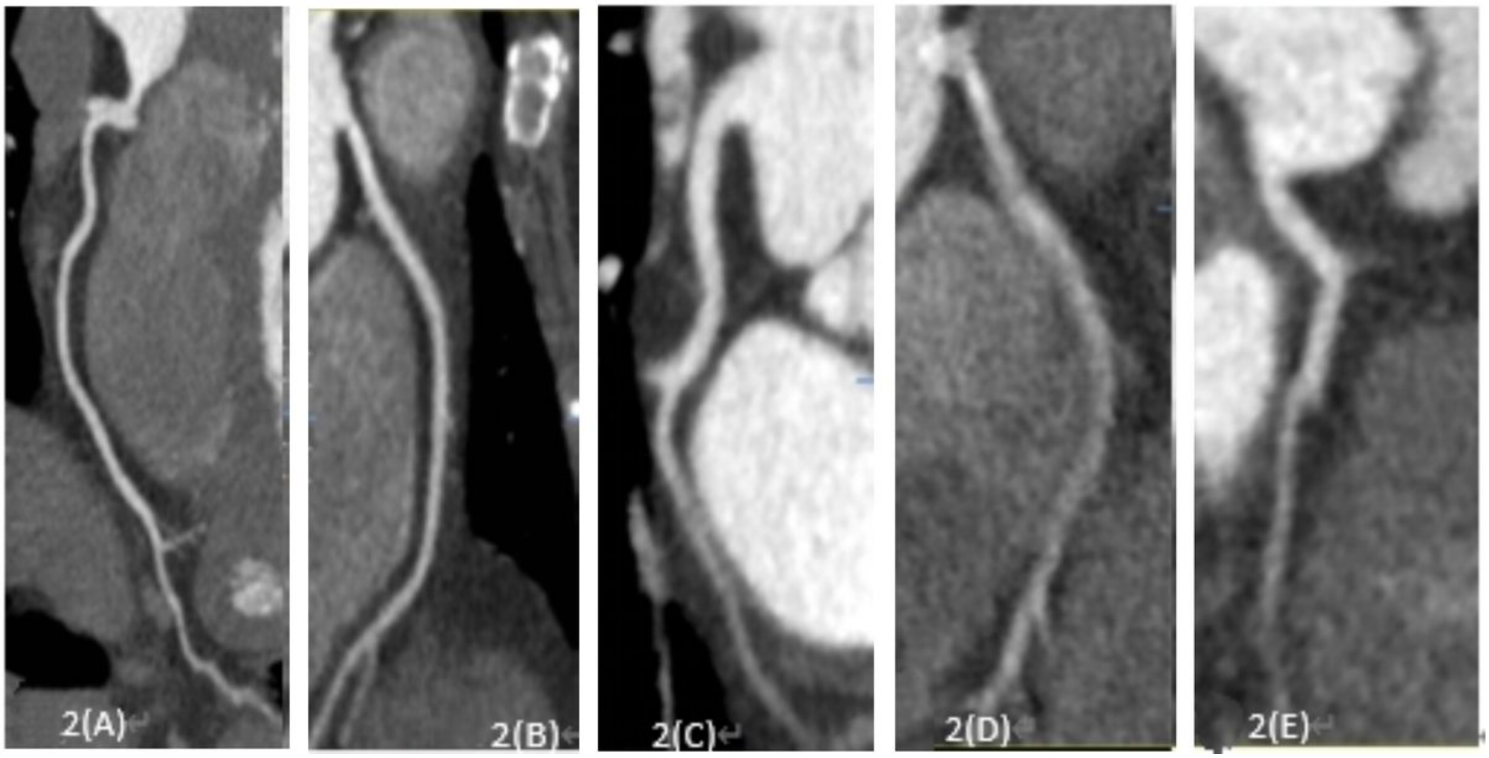



**Figure 2**

Subjective IQ scores: (a) excellent image quality (IQ; score = 5); (b) good IQ (score = 4); (c) fair IQ (score = 3); (d) poor IQ (score = 2); (e) very poor IQ (score = 1).

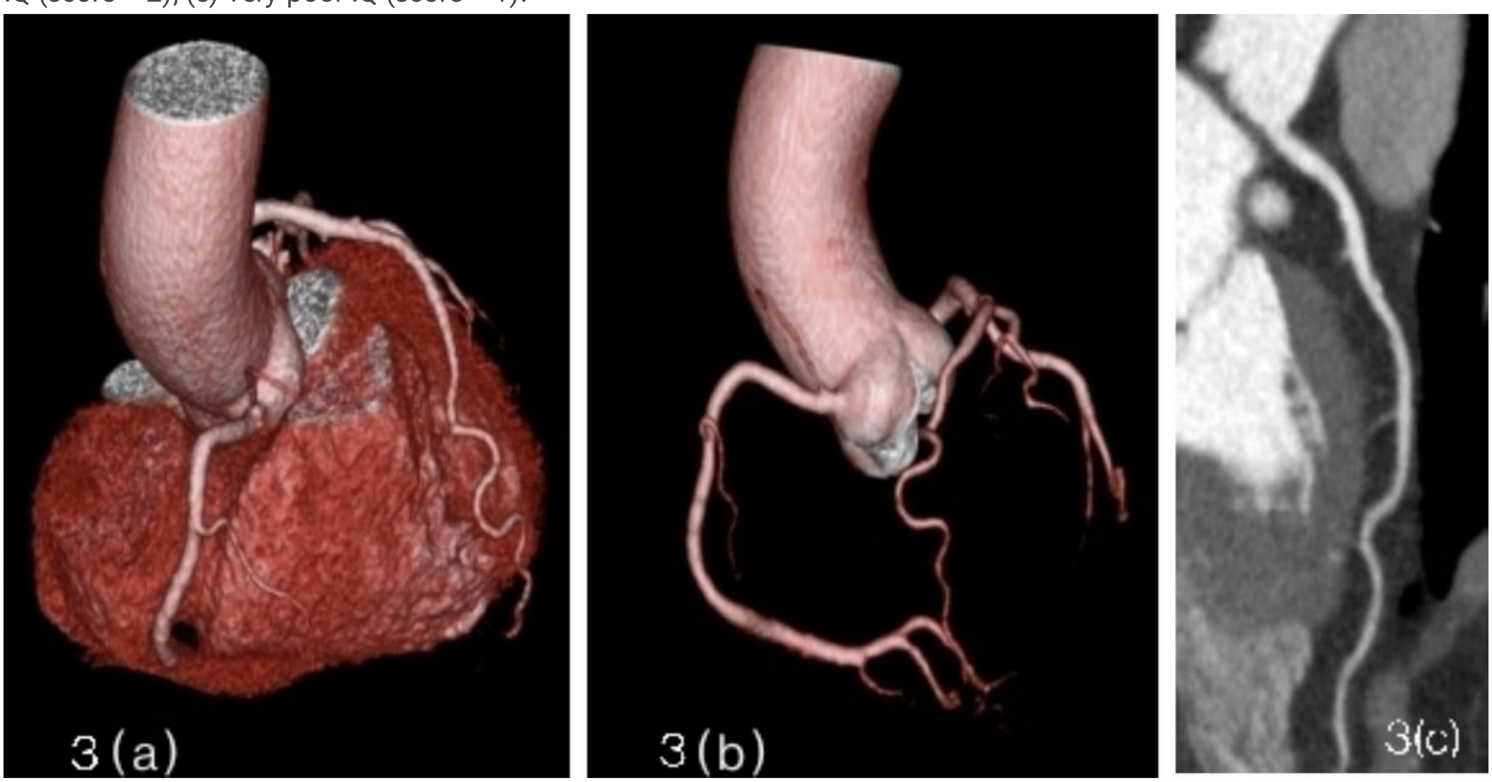



**Figure 3**

A female patient in group A1 aged 69 years. For MSCTA, the IQ score was 5 (excellent) in LAD segments 5–8. (a, b) Volume rendering (VR). (c) Curved planar reformation (CPR). BMI, 26.40; ED, 1.18 mSv; noise, 18.80; SNR, 52.68; CNR, 42.89.

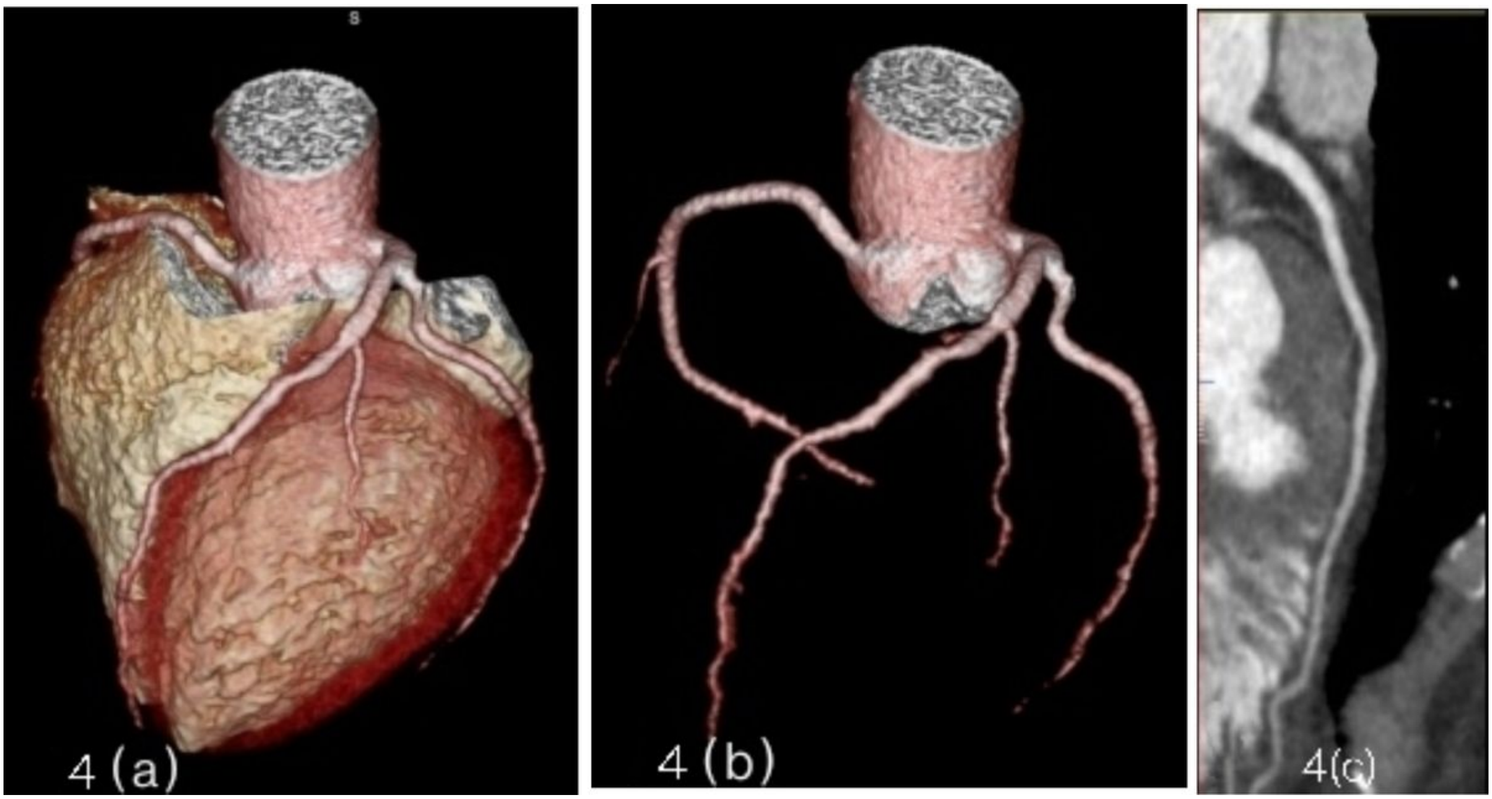
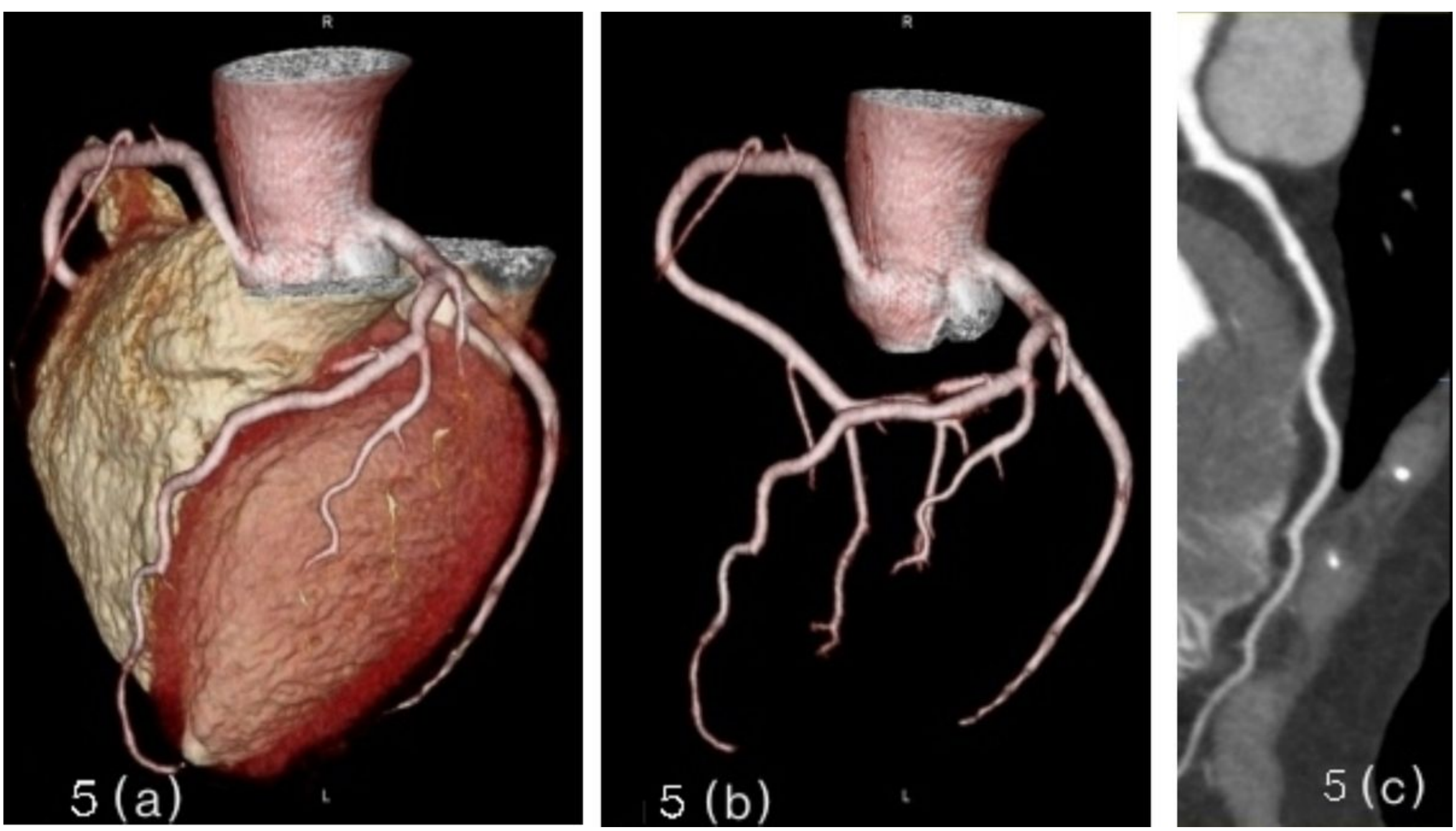


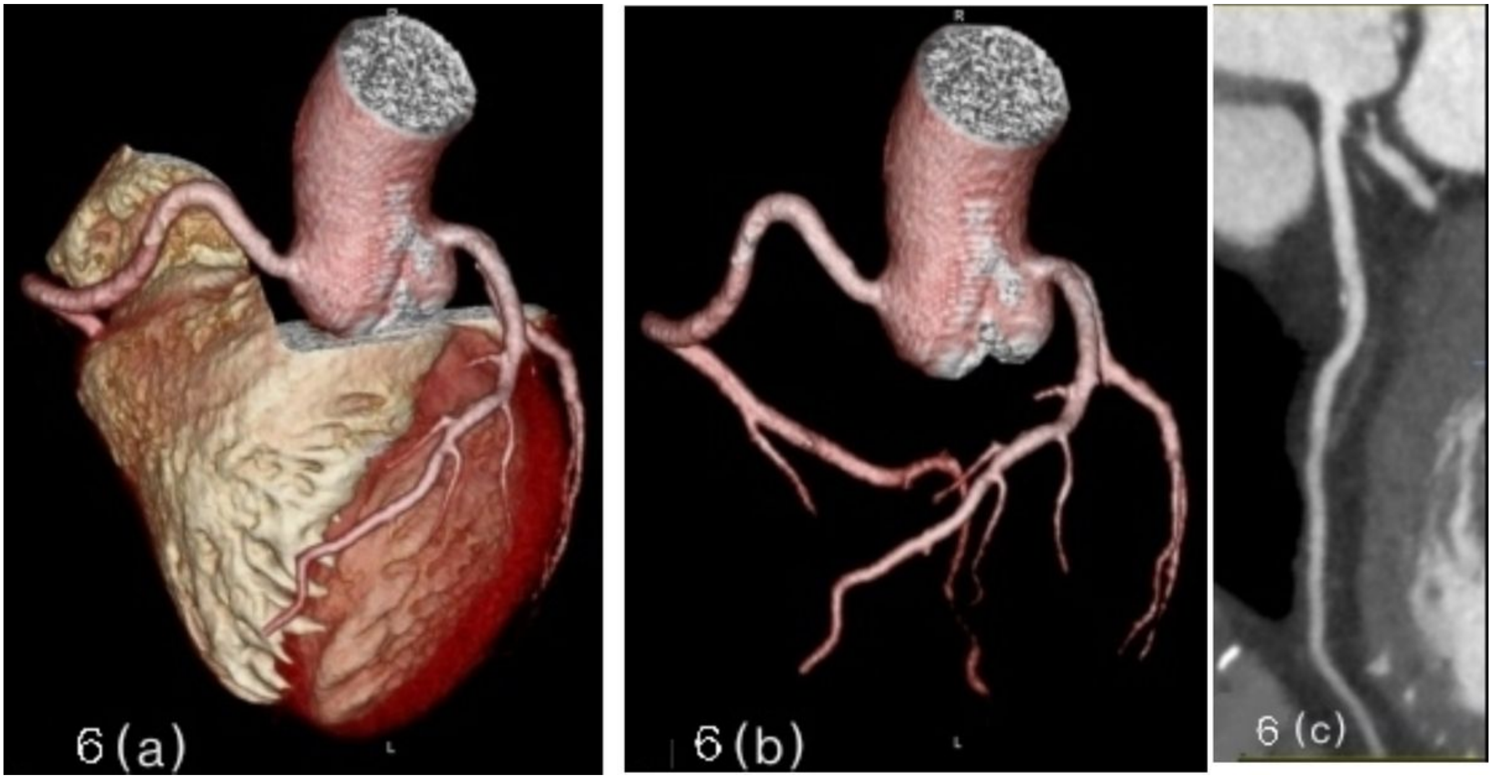

**Figure 4**

A female patient in group b1 aged 64 years. For MSCTA, the IQ score was 5 (excellent) in LAD segments 5–8. (a, b) Volume rendering (VR). (c) Curved planar reformation (CPR). BMI, 26.40; ED, 1.83 mSv; noise, 22.50; SNR, 43.90; CNR, 30.40



## Figure 5

A female patient in group A1 aged 68 years. For MSCTA, the IQ score was 5 (excellent) in LAD segments 5–8. (a, b) Volume rendering (VR). (c) Curved planar reformation (CPR). BMI, 22.38; ED, 3.33 mSv; noise, 13.10; SNR, 74.69; CNR, 58.85.




## Figure 6

A male patient in group B2 aged 55 years. For MSCTA, the IQ score was 5 (excellent) in LAD segments 5–8. (a, b) Volume rendering (VR). (c) Curved planar reformation (CPR). BMI, 28.66; ED, 5.72mSv; noise, 13.00; SNR, 69.80; CNR, 40.27.