

Impact of Artificial Intelligence-based Optimization Algorithm on Image Quality of low-dose Coronary CT Angiography

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Aims and objectives

To assess the impact of an artificial intelligence (AI)-based optimization algorithm on image quality (IQ) in low-dose (LD) Coronary CT Angiography (CCTA).

Methods and materials

Seventy subjects referred for CCTA were randomly divided into two groups (group A with 80 kVp and group B with 100 kVp) on NeuViz 128 CT. Group A was divided into two subgroups (A1, A2) according to reconstruction algorithm. Iterative reconstruction (IR) was applied to group A1 and B. Further AI-based optimization of group A1 was named as group A2. Subjective IQ was graded blindly by two radiologists with a four-point scale (1 for excellent and 4 for poor). Image noise, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated to evaluate IQ objectively.

Results

The subjective IQ score of group A2 was significantly lower than that of group A1 ($P=0.03$). The image noise of group A2 was significantly decreased while SNR and CNR were significantly increased than that of group A1 ($P<0.001$). Compared with group B, the subjective IQ score of group A1 was significantly higher ($P=0.004$) while that of group A2 has no significant difference ($P=0.899$). For objective IQ, the image noise of group A1 was significantly higher while SNR and CNR were significantly lower than that of group B ($P<0.05$). There was no significant difference in noise and SNR between group A2 and group B ($P>0.05$), but CNR in group A2 was significantly higher than that in group B ($P<0.05$) on coronary branches.

Images for this section:

| Characteristics | Group A (n=35) | Group B (n=35) | P-value |
|--------------------------|------------------------|------------------------|---------|
| Age (years) | 59.80 ± 10.70 | 56 (54 - 63) | 0.09 |
| Gender (male, %) | 20 (57%) | 17 (49%) | 0.47 |
| Height (m) | 1.65 ± 0.08 | 1.66 ± 0.07 | 0.51 |
| Weight (kg) | 62.88 ± 10.00 | 68.67 ± 13.25 | 0.07 |
| BMI (kg/m ²) | 23.01 ± 2.77 | 24.78 ± 4.60 | 0.09 |
| Heart rate (bpm) | 66.77 ± 8.05 | 66 (65 - 71) | 0.90 |
| Scan length (mm) | 125.00 (120.00-132.00) | 126.50 (120.00-133.00) | 0.91 |

Fig. 1

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| ROI | Noise | | | SNR | | | CNR | | |
|-----|-------------------------|-----------------------|-----------------------|-------------------------|-------------------------|-----------------------|-------------------------|--------------------------|---------------|
| | Group A1 | Group A2 | Group B | Group A1 | Group A2 | Group B | Group A1 | Group A2 | Group B |
| Ao | 30.12 ± 9.53** | 9.53 ± 2.65** | 16.90 (15.08 - 20.80) | 17.94 (15.21 - 26.94)** | 57.14 (49.50 - 79.22)** | 28.66 ± 10.39 | 27.82 (24.14 - 38.97)** | 72.22 (50.11 - 112.15)** | 40.79 ± 14.74 |
| LM | 33.90 ± 16.94** | 17.60 (13.93 - 22.20) | 18.80 (15.80 - 20.60) | 17.85 (13.36 - 26.43)** | 28.75(23.40- 43.63) | 26.15 ± 8.21 | 26.72 (22.32 - 38.76)** | 70.56 (47.58 - 102.66)** | 39.86 ± 15.45 |
| LAD | 27.50 (18.03 - 33.50)** | 18.00 (11.18 - 25.60) | 18.60 (16.83 - 21.10) | 20.28 (14.60-25.63)** | 28.17 (16.11 - 43.44) | 25.17 (20.53 - 31.84) | 26.62 (19.46 - 37.30)** | 67.57 (44.91 - 98.57)** | 38.94 ± 13.70 |
| LCA | 29.30 ± 12.12** | 21.35 ± 11.98 | 21.00 (17.33 - 24.90) | 19.88 (15.99 - 21.98)** | 24.72 (17.80 - 38.16) | 23.49 (19.00-28.99) | 25.32 (19.76 - 34.32)** | 63.77 (44.70 - 108.12)** | 39.16 ± 14.00 |
| RCA | 25.80 (22.03 - 37.30)** | 16.90 (11.73 - 29.10) | 19.50(14.40-23.50) | 17.58 (12.11 - 25.43)** | 28.06 (14.70 - 51.33) | 23.54 (20.46 - 30.16) | 25.04 (18.82 - 33.90)** | 58.88 (43.74 - 95.32)** | 38.22 ± 12.65 |

Fig. 2

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| Group No. | Segment number | 1 Score | | 2 Score | | 3 Score | | 4 Score | | Kappa Value |
|-----------|----------------|-------------|-------------|-------------|-------------|-----------|-----------|-----------|-----------|-------------|
| | | Reader 1 | Reader 2 | Reader 1 | Reader 2 | Reader 1 | Reader 2 | Reader 1 | Reader 2 | |
| Group A1 | 414 | 133(32.13%) | 130(31.40%) | 242(58.45%) | 245(59.18%) | 29(7.00%) | 29(7.00%) | 10(2.42%) | 10(2.42%) | 0.78 |
| Group A2 | 414 | 188(45.41%) | 178(43.00%) | 198(47.83%) | 208(50.24%) | 18(4.35%) | 18(4.35%) | 10(2.42%) | 10(2.42%) | 0.81 |
| Group B | 429 | 180(43.48%) | 174(42.03%) | 216(50.35%) | 223(51.98%) | 21(4.90%) | 20(4.66%) | 12(2.80%) | 12(2.80%) | 0.78 |

Fig. 3

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| Radiation dose | Group A (n = 35) | Group B (n = 35) | P-value |
|---------------------------|------------------|------------------|---------|
| CTDI _{vol} (mGy) | 4.65 ± 1.00 | 12.49 ± 3.81 | < 0.001 |
| DLP (mGy•cm) | 66.61 ± 15.37 | 150.19 ± 28.94 | < 0.001 |
| ED (mSv) | 0.91 ± 0.22 | 2.10 ± 0.41 | < 0.001 |
| CM volume (mL) | 44.46 ± 7.00 | 70 | NA |
| Injection rate (mL/s) | 3.18 ± 0.50 | 5 | NA |

Fig. 4

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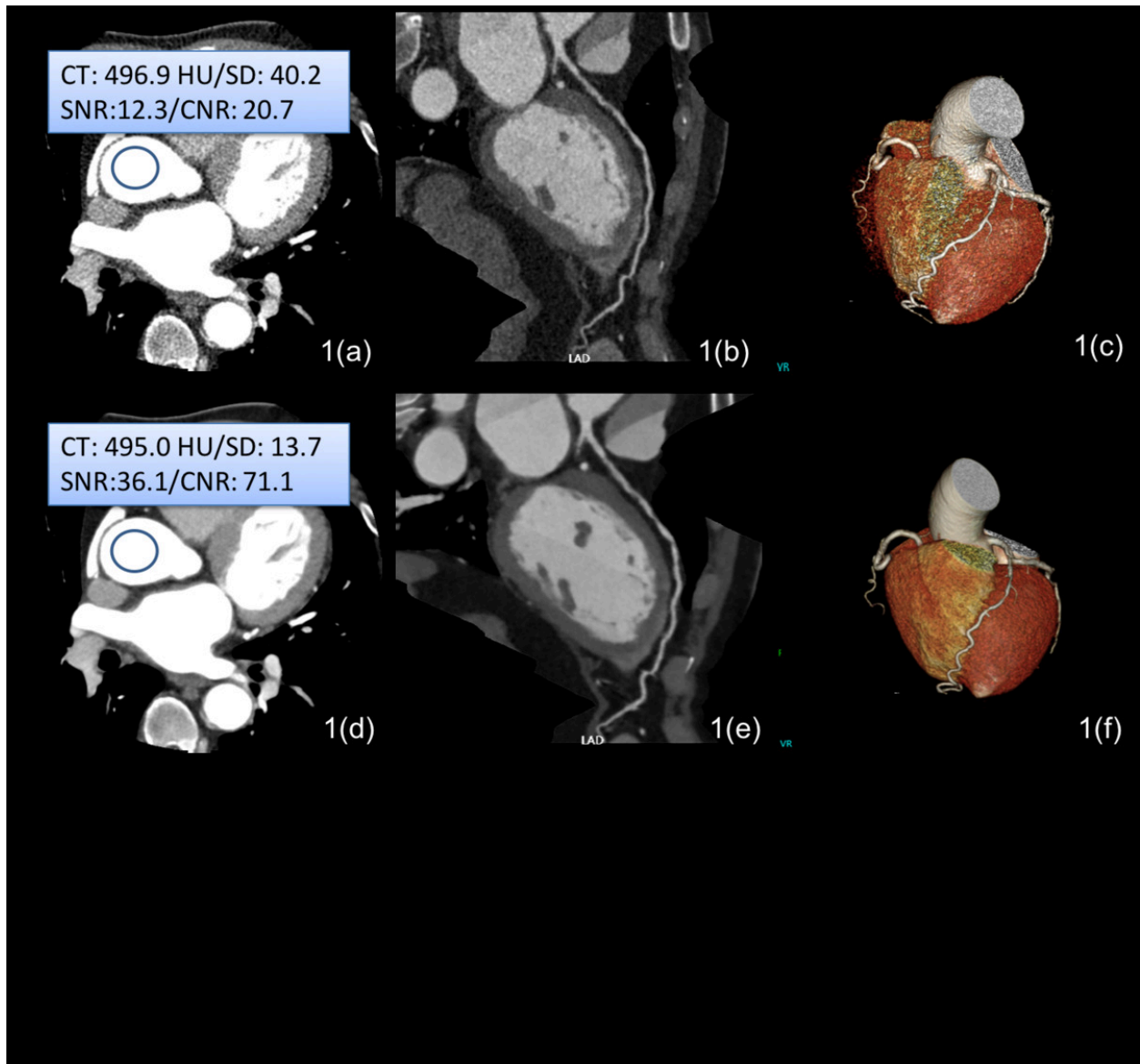


Fig. 5

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Conclusion

The AI-based optimization algorithm could effectively improve IQ of LD CCTA.

Personal information

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