The reviewing of the scanning parameter in case of the cardiac CT examination which used the noise reduction filter

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Learning objectives

We reviewed the scanning parameter of the cardiac CT examination which used the noise reduction filter.

Background

Cardiac CT examination has low invasiveness compared with cardiac catheterization examination. However, a problem is that there are many exposure dose\(^1\). In order to solve this problem, we are examining the noise reduction filter carried in CT scanner.

Two kinds of noise reduction filters, Cardiac filter and Neuro3D filter, are carried in the CT scanner which we are using. We performed comparison and examination of Cardiac-filter and Neuro3D-filter, and reported by ECR2009. Neuro3D-filter did not reduce spatial resolution and we found reducing image SD value a maximum of 40% from the result. The outline of Neuro3D-filter is shown (Fig.1 on page 2). Neuro3D-filter has three kinds from which the intensity of N1 (Low), N2 (Med), and N3 (High) differs.

Neuro3D-filter is a spatial frequency filter. The reason is because it can process in image series with the image of three or more sheets.

This time, we examined the scanning parameter of cardiac CT examination which used Neuro3D-filter. We examined the scanning parameter especially paying attention to X-ray tube voltage. N1 was excepted from this examination. It is because the noise reduction effect is as low as several percent as a reason.

Images for this section:
Fig. 1 Information about Neuro3D filter

For general purpose.
Three different filters.
Low (N1), Med(N2), High(N3)
Three or more consecutive images are simultaneously processed. ➡️ **Spatial filter**

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**Fig. 1**

- **SD value and electric current**
  - Tube voltage: 120kV
  - SD value vs Electric Current (mA)

- **MTF**
  - Original, N1, N2, N3
  - Modulation Transfer Factor vs Spatial Frequency (cycles/mm)
Imaging findings OR Procedure details

Materials (Fig.2 on page )

1. Multi slice CT scanner

We used the 32-detector CT scanner "LightSpeed VCT Select (GE Healthcare)".

2. Oval water phantom (300mm×200mm)

3. Blood vessels phantom "There are three (25%#50%#75%) of narrow-segments."

4. Image processing workstation "Advantage Workstation Ver4.4 (GE Healthcare)"

Method

1) Measurement of image SD and exposed dose.

First, tube voltage and tube current were changed and the oval water phantom was scanned. The obtained image was processed with the noise reduction filter, and the image SD value was measured. ROI was set as the phantom image and SD was measured. In the same section of original image and a filter processing image, SD value in a water phantom was measured at five points, and the average value was computed (Fig.3 on page ).

We measured the tube voltage in a cardiac CT examination, and the relation of CTDIvol. Scanning parameters are shown in Fig.4 on page . The scan range was set as 120mm in consideration of the size of the heart.

2) Relation between X-ray tube voltage and CT value.

We poured in 1-8ml of contrast media to 200ml of water, and created dilution contrast media. The used contrast media is Iohexol with a concentration of 350mgI/ml. Each dilution contrast media changed tube voltage, and was scanned. From the obtained image, we measured CT value and investigated the relation between tube voltage and CT value.

3) Influence which a noise reduction filter has on image processing.

We scanned the blood vessel phantom on different X-ray tube voltage of 100 kV and 120 kV. We used automatic processing of a workstation. A reason is for giving objectivity to a measurement result.
The short axis and the long axis in the cross section of the blood vessel phantom were measured. The strangulation part of the blood vessel phantom measured eight sections, respectively. We calculated the average value of the measurement result, and evaluated average value by t-test.

**Result**

1) The relation between tube voltage change and picture SD is shown (fig.5 on page ). It was based on the picture obtained by scanning with the tube voltage of 120kV. As for SD, the image with a tube voltage of 120 kV and the image with a tube voltage of 100 kV processed by N2 became almost the same. Moreover, SD of the picture processed by N3 has improved rather than SD of the image scanned at 120kV.

Change of CTDIvol by the difference in tube voltage is shown (Fig.6 on page ). The value of CTDIvol can be reduced if tube voltage is changed and scanned from 120kV to 100kV. If tube voltage is changed and scanned from 120kV to 100kV, a CTDIvol value can be reduced about 38%.

2) When tube voltage was changed and dilution contrast media was scanned, CT value with the higher low tube voltage scan was acquired. Comparison of CT value acquired by the tube voltage scan of 100kV and CT value acquired by the tube voltage scan of 120kV obtained one 1.2 times the value of this for the way of CT value acquired by the tube voltage scan of 100kV. It did not depend for this result on the concentration of dilution contrast media (Fig.7 on page ).

3) The measurement result of the diameter of the blood vessel phantom is shown (Fig.8 on page ). Even if tube voltage was changed and it scanned it, there was no significant difference in the diameter measurement result of a blood vessel phantom. The result of t-test was P> 0.05 in all.

**Discussion**

By carrying out Neuro3D filter use, even if scanned with the tube voltage of 100 kV, it was suggested that I can maintain image quality. However, in a big patient, security of image quality also has a limit. Then, it will be necessary to change not only tube voltage change but change of tube current. We would like to examine the further scanning parameter from now on.

The advantage of tube voltage the scan of 100 kV is the possibility of exposure dose reduction and reduction of the amount of the contrast media used accompanying a contrast rise to tube voltage the scan of 120 kV. This not only reduces the burden of a patient’s body, but contributes to medical economics greatly. However, since change of
CT value arises by tube voltage change, we have to perform plaque quality measurement carefully.

**Clinical use**

A clinical image is shown (Fig.9-1 on page , Fig.9-2 on page , Fig9-3 on page ).

A patient is the male of his 60's age. This patient conducts cardiac CT examination every year for angina pectoris.

In the cardiac CT examination enforced in 2007, we scanned using the tube voltage of 120 kV. The obtained image was good quality. On the occasion of the cardiac CT examination in 2008, it scanned by changing only tube voltage into 100kV. The obtained image was processed by N3 and compared with the image in 2007.

We measured and compared SD value of each image. The place which measured SD is an ascending aorta of the height of left main trunk. The measurement result of SD is shown below.

<table>
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<tr>
<td>120kV#24.39</td>
<td></td>
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<tr>
<td>100kV processing by N3 filter#21.93</td>
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Next, the value of CTDIvol recorded when each inspection was conducted is shown below.

<table>
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<tr>
<td>120kV#75.76mGy</td>
<td></td>
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<tr>
<td>100kV processing by N3 filter#46.97mGy</td>
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The 100-kV scan could reduce the dose of radioactivity 39% compared with a 120-kV scan, and this result was not contradictory to basic examination. The image quality of the scanning image using 100kV processed by N3 was maintained also in any of an axial image, CPR (Curved planar Reconstruction) image, and VR (Volume Rendering) image.
Conclusion

The scanning parameter which combined the low tube voltage scan and the noise reduction filter in the cardiac CT examination enables reduction in exposure dose, maintaining image quality.

Moreover, a low tube voltage scan raises CT value of contrast media. Therefore, the quantity of the amount of the contrast media used can be decreased (Fig.10 on page ).

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References