Characterization of Artifact Simulating Aortic Dissection in Computed Tomography Imaging

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An artifact simulating aortic dissection has been seen in computed tomography (CT) and reported in numerous journals. The purpose of this study is to determine the origin. A phantom was constructed to simulate the motion of the ascending aorta during the cardiac cycle. Technique factors such as scan time, slice thickness, pitch, and reconstruction algorithms were examined for their effect on the simulated dissection appearance. Change in the angle of the simulated aorta with respect to the scanner axis was also studied. CT images displaying the simulated aortic dissection are obtained reproducibly. The amplitude of the artifact is more pronounced for increased scan time. The artifact amplitude is proportional to the displacement of the phantom. The simulated aortic dissection seems to be more pronounced when the scan time is comparable to the cycling time of aortic motion.

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THE APPEARANCE OF an aortic dissection artifact in thoracic computed tomography (CT) examinations has been noted by researchers.¹ The artifact is displayed in images as a simulated aortic dissection near the aortic root. Qanadli et al reported that in 75% of 360°-reconstructed thoracic CT examinations and 37% of 180°-reconstructed thoracic CT examinations the motion of the aorta produces artifacts.² They went on to define the axial extent and amplitude of the artifact and suggest using a 180° reconstruction algorithm to reduce the artifact's amplitude. Batra et al have stated that the motion of the aortic root produces a dissection artifact or circular artifact on the aortic root. They also suggest this artifact can be minimized by using a 180° reconstruction algorithm or ultrafast electron beam CT.³

Several factors may be the cause of this artifact such as scan technique factors, aortic speed and displacement, angle of the aorta with respect to the scanner axis, or use of different reconstruction

algorithms. The purpose of this investigation is to evaluate the artifact through phantom images.

A phantom was created to simulate the motion of the aorta during the cardiac cycle. Aorta parameters as stated by Feigenbaum⁴ were used to create the phantom. Plastic tubing with a diameter of 3.7 mm and a wall thickness of 2 mm is used to simulate the aorta and the motion is given by a motor lifting the plastic tube anterior to posterior through 1 cm in one upward motion with one complete cycle per second. The images were taken with the phantom in air. A General Electric (Milwaukee, WI) CT/I 1998 model scanner was used with 180° reconstruction for all helical imaging, and 360° reconstruction for axial imaging.

Technique factors such as gantry tilt, slice thickness, pitch, and convolution filters were examined for their effect on the simulated dissection appearance. The aorta phantom is adjusted to allow the effect of aorta displacement and speed to be studied. Change of the angle of the simulated aorta with respect to the central axis and its effect on the simulated dissection was also studied.

CT images displaying the simulated aortic dissection are obtained reproducibly for scans using 360° reconstruction. The amplitude of the artifact, which is defined as the maximum distance between the centers of the simulated dissection and the wall of the phantom, is independent of the slice thickness, gantry tilt, and convolution filter. As the displacement of the aorta increases from 6.7 mm to 15.0 mm for the same cycle time, the average artifact amplitude increases from 6.25 mm to 15.7 mm. These data were fitted to a line (slope = 1.1 ± 0.4) with linear regression and found to correlate well (r value of 1.0). As the angle increases by 10° between the phantom axis and central axis of the scanner, the CT number decreases along the corresponding edges and the width of the aorta increases by approximately 5%, but no increase in the amplitude of the artifact is seen.

Both 180° and 360° reconstruction algorithms show an artifact, but 360° reconstruction shows the dissection artifact more completely as can be seen by comparison of Figs 1 and 2. With helical or 180° scanning, the appearance of the artifact is incomplete and not easily quantified.

We have shown that a CT scan of the moving

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Fig 1. Axial CT scan of aorta phantom with aorta moving with cycle of 1 second and displacement of 1 cm (360° reconstruction).

aorta phantom does produce an artifact simulating dissection. This artifact appearance is affected by aorta speed and displacement suggesting that motion is the root cause of the artifact. Use of helical scanning may minimize the appearance of some dissection artifacts if the cardiac cycle is significantly longer than the scan time. But, if a cardiac cycle were shorter than the time needed to collect 180° of data, helical scanning with 180° reconstruction would then display the dissection artifact.

Work continues to obtain data for a low contrast phantom as encountered in a patient. Also, creation of a computer model of the phantom is underway

Fig 2. Helical CT scan of aorta phantom with aorta moving with cycle of 1 second and displacement of 1 cm (180° reconstruction).

thereby allowing the various parameters of the scan to be adjusted to determine the solution to minimizing the dissection artifact.

REFERENCES

1. Loubeyre P, Grozel F, Carrillon Y, et al: Prevalence of motion artifact simulating aortic dissection on spiral CT using a 180° linear interpolation algorithm for reconstruction of the images. *Eur Radiol* 7:320-322, 1997
2. Qanadli S, El Hajjam M, Mesurolle B, et al: Motion artifacts of the aorta simulating aortic dissection on spiral CT. *J Comput Assist Tomogr* 23:1-6, 1999
3. Batra P, Bigoni B, Manning J, et al: Pitfalls in the diagnosis of thoracic aortic dissection at CT angiography. *Radiographics* 20:309-320, 2000
4. Feigenbaum H: Appendix, in *Echocardiography* (ed 5). Philadelphia, PA, Lea & Febiger, 1994, pp 658-664