자유호흡을 하는 소아환자에서 컴퓨터 단층 혈관조영술의 호흡 인공물 감소를 위한 최적 촬영조건에관한 연구 : 모형 실험

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Optimization of Scan Protocol for Reducing Respiratory Artifacts in Free Breathing CT Angiography of the Pediatric Patients : Phantom Study

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1. Introduction

After the introduction of computed tomography(CT), angiographic imaging by CT has made contributions in noninvasive vascular imaging, but there were some limitations due to slow scan speed of CT machines and unsatisfactory computing powers. After helical CT and multi-detector row CT(MDCT) has come into clinical field, image generation on the base of volume acquisition has become possible, and CT angiography(CTA) is one of the major benefits.

The feasibility of CTA has made it an important imaging tool in diagnosis and follow up of patients with vascular disease, both young and old. There are many informations about the techniques and application for CT angiography in adults, but not so much informations are available for imaging of children, who undergo CTA due to their congenital heart disease and assoicated vascular anomalies.Children are different from adults in various points, such as their body size, circulation time, respiratory cycle and breath-holding ability; in regard to CT machines, several factors such as scan time, radiation dose, and amount and rate of contrast media to be injected should be considered to determine adequate protocol and to get proper images.

To our knowledge, there has been no study that clearly revealed adequate relationships and combinations of various factors such as scan time, beam collimation, and image reconstruction interval. We have tested CTA data acquisition under various conditions and reviewed the images.

We think it would be helpful to determine appropriate scan protocols of CTA for children with congenital heart disease and associated vascular abnormalities in major vessels.

2. Methods

We made amimicking vascular stenosis for this study. The phantom hastwelve polyethylene tubes with variable diameters are placed; the largest one lies along the long axis of the cage, has no stenosis and branch out eleven smaller tubes; ten tubes run parallel to each other and perpendicular to the largest one, six of them have stenotic segments and four of them have no stenosis; the last one branch obliquely from the largest one and makes a landing to the wall of a cage.

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Thevessels wereof contrast media(Ultravist 370; Schering, Berlin, Germany) andsaline in the ratio of 1.7:100, and outerspace of the tubeswas filled with distilled. The phantom was placed on the moving table of CT machine(SOMATON Sensation16; Siemens Medical Solutions)with the long axis parallel to the axis of scanning.

The fixedof CT protocol were as follows : 100 effective mAs, 80kVp, soft tissuebeam collimation of 16x0.75mm, reconstruction thicknenss of 1mm and reconstruction interval of 0.5mm

The variable factors of CT protocol were as follows : three conditions of pitches0.5, 1, and 1.5;conditions of gantry rotation time0.37 and 0.75 second. Overall six conditions were applied to each of movment condition.

To simulate the breathing movement of children, a small ventilator was tomake periodical movement with constant range. Overall five conditions were applied ; images with no movement were acquried first, and then the phantomwas moved back and forth in overall four conditions ; 2cm and 4cm for movement width, and 20RPM and 40RPM for respiration rate.

From data achieved with five sessions of imaging, 120 MIP images were generated using a 3D-CT Rapidia program(INFINITT Technology, Seoul, Korea).

All of the tubes in the MIP images were evaluated with grading system. For six tubes with stenosis, grade 0 (for the worse images) to 2 (for the better images) was given according to the degree of artifact. For four tubes without stenosis, grade 0 to 2 was.

For the conditions with relatively slow movement (movement width of 1cm and rate of 20RPM 1cm - 40RPM), overall results were improvedas the scan speed increased.

For the conditions with relatively fast momvent(3cm-20RPM and 3cm-40RPM), scan condition with same pitch and differentrotation time gave out simlar results.

This is probably because the scans might be overlapped with a faster gantry rotation and relatively slower table speed.

With the increase of scan speed by increase of pitch and/or decrease of rotation time, the points for each scan conditions also generally increased.

3. Conclusions

The most important factor to decrease motion artifact in CT scanning is the speed of scan.

Among the controllable factors of CT machine, the control of pitch is more effective in affecting the artifacts than the control of gantry rotation time.

References

1. Ronald C, Donal F, Lane D. Data acquisition for pediatric CT angiography: problems and solutions. Pediatr Radiol 2000;30: 813-822.
2. Leo L, Elliot F. Multi-Detector Row CT of Thoracic Disease with Emphasis on 3D Volume Rendering and CT Angiography. Radiographics 2001; 21: 1257-1273.
3. Marilyn S. Multiplanar and Three-dimensional Multi-Detector Row CT of Thoracic Vessels and Airways in the Pediatric Population. Radiology 2003; 229:641-650.
4. Mannudeep K, Michael M, Thomas T, Leena H, Michael B, Jo-Anne S, et al. Strategies for CT Radiation Dose Optimization. Radiology 2004; 230: 619-628.