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Author(s)	齋藤, 春夫; 渡部, 信之; 新田, 敏夫 他
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胸部CTにおけるモーションアーチファクト
—フルスキャンとハーフスキャンとの比較—

齋藤　春夫[1)*]　渡部　信之[1)]　新田　敏夫[1)]
高橋　昭喜[2)]　坂本　澄彦[2)]

1) NTT 東北病院放射線科　2) 東北大学医学部放射線医学教室
＊現 石巻赤十字病院放射線科

Motion Artifacts on Chest Computed Tomogram : Full Scan Versus Half Scan

Haruo Saito[1)*], Nobuyuki Watabe[1)], Toshio Nitta[1)], Shoki Takahashi[2)] and Kiyohiko Sakamoto[2)]

1秒前後のスキャン時間の胸部CT画像では，主として心臓の動きに起因する2重輪郭アーチファクトが出現し，大動脈解離や気管支拡張症などと紛らわしい場合がある．この2重輪郭アーチファクトは、half-scanに再構成すると単一構造として認識できることが多い．full-scanとhalf-scanとで比較し，これらのアーチファクトの出現頻度を検討した．大動脈基部の2重輪郭はfull-scanの38/50で認め，このうちの31箇所はhalf-scanに再構成すると単一構造として認識された．肺野条件の画像でも，full-scanで2重構造に見え，再構成したhalf-scanで単一の線状構造として認識された肺血管影などで，アーチファクトと考えられる構造が25/150側の肺野で観察された．一方，half-scanでは大動脈基部の輪郭が19/50で不明瞭となった．2重輪郭アーチファクトを除外するために胸部ではhalf-scanが望ましいが，half-scanのみでは画像が粗くなることや，本来の構造が不明瞭となるアーチファクトが少なからず認められるので，full-scanで検査を行い，アーチファクトが疑われる断面でhalf-scan再構成を行っておくのがよいと考えられる．

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Introduction

Artifacts seen on computed tomograms (CTs) have long been a confounding factor in the diagnosis of aortic dissection or bronchiectasis[1)-3)]. Occasionally, double-contour images of the aortic root and the pulmonary vessels can be seen on the chest CT whose scan times were 1.0 sec. We recently noticed that these artifacts usually were seen on full-scan CT images, and that some of them became unclear on each reconstructed half-scan image. Therefore, this study was carried out to demonstrate the clinical usefulness of differentiating double-contour artifacts from bona fide lesions by comparing the full- and half-scan reconstructed CT images.

Materials and Methods

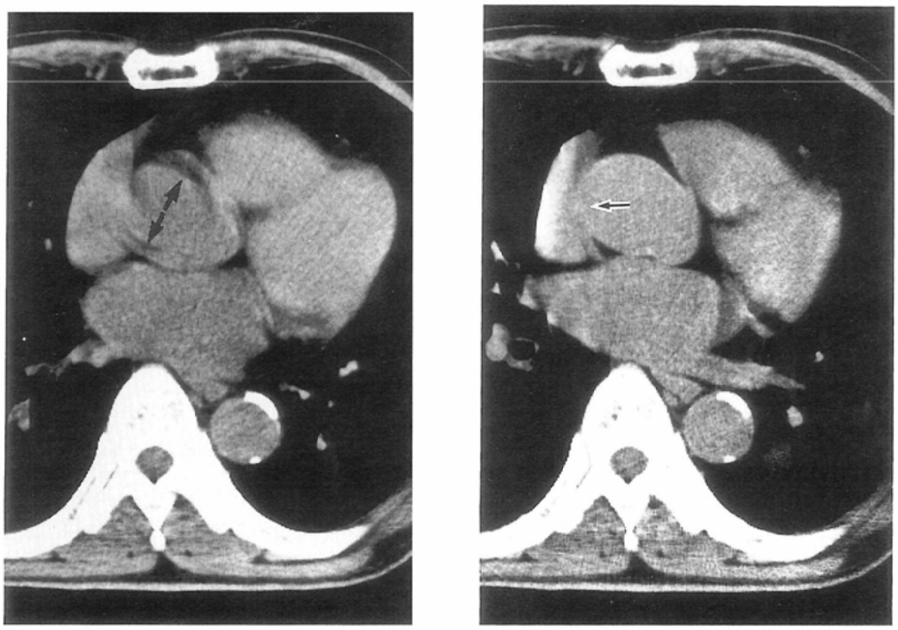
A TCT-900 S Scanner (Toshiba, Japan), with a continuously rotating CT system, was used in this study. Using this scanner, it was possible to

1) Department of Radiology, NTT Tohoku Hospital / 2) Department of Radiology, Tohoku University, School of Medicine /
＊ Present address : Department of Radiology, Ishinomaki Red Cross Hospital

obtain 1.0 sec full-scan images using the data from all detectors set around the gantry (360 degrees) ; and each reconstructed half-scan image, about 240 degrees, was obtained from the data from the corresponding half-scan (180 degrees) plus the fan beam angle of the detectors (60 degrees).

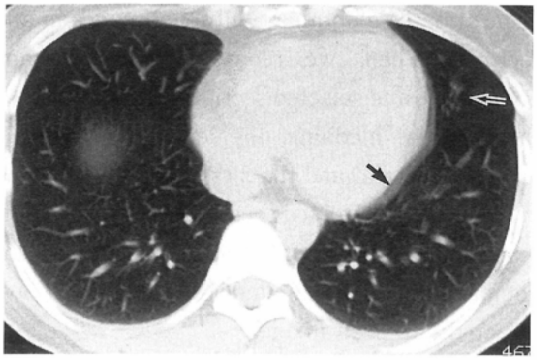
To evaluate the frequency of the artifacts on clinical chest CT, we used chest CT examinations of 25 patients which were performed for a variety of non-selected indications. None of the patients were diagnosed as having aortic dissection nor bronchiectasis. All studies included images from the base of the heart through the aortic arch. In all patients, CT examination without and with the contrast medium were made. Scan time, thickness, and the gap between sections were 1.0 sec, 5 mm, and 5 mm, respectively. All scans were obtained at full inspiration. We obtained full-scan images in all sections. Then, we reconstructed half-scan images in three selected sections of the CT with the contrast medium: the level of proximal ascending aorta, and the 3-cm caudal and 3-cm cranial levels. We used these three pairs in each examination, a total of 75 pairs (25 patients), to compare the full-scan images with the reconstructed half-scan images.

The artifacts expressed in this study were as follows: (1) an apparent intimal flap and/or double lumen of the ascending aorta (Fig. 1 (A))[1], (2) the blurring of the contour of the ascending aorta (Fig. 1 (B)), (3) the double contour of the left ventricular posterior wall (Fig. 2 (A)), (4) the double-fissure sign[2], not shown in the figure, and (5) a double contour of the pulmonary vessels (Fig. 2 (A))[3]. Images were reviewed together by two observers.



(A) (B)

Fig. 1 (A), (B) A full scan image (A) and its reconstructed half scan image (B) at the level of the proximal ascending aorta. The apparent double contour of the ascending aorta (arrows) and the blurring artifact of the contour of the ascending aorta (open arrow) can be seen. Artifacts in this case are too obvious to misdiagnose as bona fida lesions.



(A)

(B)

Fig. 2 (A), (B) A full scan image (A) and its reconstructed half scan image (B) at the level of 3-cm caudal to the proximal ascending aorta. The double contour of the left ventricular posterior wall (arrow) and pulmonary vessels (open arrow) were seen only in the full-scan image.

Results

Double-contour artifacts at the ascending aorta were depicted in 38 of 50 full-scan CT images (76%), 31 of which (82%) became unclear on each reconstructed half-scan image. Blurring of the contour of the ascending aorta was depicted in 19 of 50 reconstructed half-scan images (38%), 10 of which (53%) appeared normal in the corresponding full-scan images (Table 1).

In Table 2, the number of double-contour artifacts seen on the full-scan images, which became unclear on each reconstructed half-scan image, are given. Double-contour artifacts of the pulmonary vessels were shown in 20 of 75 full-scan CT images (33%) in the left lung fields, and in 5 of 75 ones (7%) in the right lung fields. Double-contour artifacts of the posterior wall of the left ventricle were shown in 13 of 25 full-scan CT images (52%).

The noise levels on reconstructed half-scan CT images were higher than the corresponding full-scan images (Figs. 1, 2).

Discussion

Technological developments in the field of CT scanners have allowed scan times to be

Table 1 Artifacts at the ascending aorta

level of scan	double contour				blurring of contour			
	none	full-scan only	half-scan only	both	none	full-scan only	half-scan only	both
3.0 cm cranial level	5 (20%)	17 (68%)	0	3 (12%)	16 (64%)	0	5 (20%)	4 (16%)
proximal ascending aorta	7 (28%)	14 (56%)	0	4 (16%)	15 (60%)	0	5 (20%)	5 (20%)

Table 2 Double contours on full-scan images

level of scans	fissures		pulmonary vessels		posterior wall of left ventricle
	left	right	left	right	
3.0 cm cranial level	0	0	4 (16%)	0	
proximal ascending aorta	2 (8%)	0	9 (36%)	2 (8%)	
3.0 cm caudal level	0	0	7 (28%)	3 (12%)	13 (52%)

reduced to as little as 1.0 sec, even in 3 rd generation CT scanners, and double-contour artifacts have been demonstrated on chest CT at these scan times[1)-3)]. The authors have experienced double-contour artifacts and blurred artifacts on chest CT when the scan time was 1.0 sec. In the present study, some of the double-contour artifacts found on the full-scan CT images became unclear on each reconstructed half-scan image, but the half-scan images have higher noise levels and have a greater number of artifacts, such as blurring, compared to full-scan images.

Mayo et al. speculated that the double-fissure artifact was caused by fine structures in the lung which contributed significantly to x-ray attenuation only when they were viewed end on or from a position perpendicular to the x-ray beam. The result was that motion that occurred between those points in time when the beam was tangent was not observed in the scan. Therefore, one did not see a conventional spray artifact but rather saw two well-resolved lines[2)]. Although this hypothesis may partly explain the cause of the double-contour artifacts on full-scan images, it cannot explain the low detection rate of the double-contour artifacts on the reconstructed half-scan CT because 0.6 sec, the scan time of the half-scan, was not short enough to eliminate the effect of the cardiac motion.

Yang et al. clearly showed the cause of streaking artifacts on the translate-rotate scanning geometry and also predicted that the fan beam geometry should result in different streaking characteristics[4)]. It is the opinion of the present authors that the double-contour and the blurring artifacts found on the chest CT arise from cardiac motion, about 1 beat/sec, during image acquisition, and also that the fan beam irradiation mechanism and the filtered back-projection technique for image constraction in CT may also contribute the formation of these artifacts.

We used 5 mm sections in this study. The artifactual bronchiectasis and the double-fissure sign were apparent in thin-section CT images[2),3)]. Therefore, the incidence of the artifacts in different section thickness, such as 1 mm, 2 mm, and 10 mm et al. should be examined. And one practical problem in our approach is the narrow raw data area of the disc drive on a usual CT scanner. Thus, we should review the examination quickly after its completion, and decide on which sections half-scan reconstructions should be done.

On the newer fast scanners with scan times of about 1.0 sec, the double-contour artifacts mainly caused by cardiac motion were sometimes experienced on full-scan chest CT which may falsely be interpreted as evidence of a lesion. Some of these artifacts could be distinguished from lesions because they became unclear on each reconstructed half-scan image, but the half-scan images have poorer resolution, higher noise levels, and blurring. Therefore, a comparison of both full-scan and reconstructed half-scan images in chest CT should be performed to differentiate double-contour artifacts from bona fide lesions resulting from aortic dissection or bronchiectasis.

Conclusion

With scan times of about 1.0 sec, double contour artifacts caused by cardiac motion could be seen on full-scan chest CTs. Examinations of 25 patients showed that double-contour artifacts could be seen on full-scan CT, and some of these artifacts became unclear on each reconstructed half-scan image. However, half-scan images were noisier than full-scan images, and blurred artifacts became apparent on half-scan images. Therefore, a comparison of both full-scan and reconstructed half-scan images in chest CT should be performed to differentiate double-contour artifacts from bona fide lesions.

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