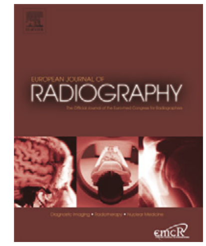
European Journal of Radiography (2009) 1, 73—79

available at www.sciencedirect.com

ScienceDirect

journal homepage: http://ees.elsevier.com/ejradi



Artifacts in spiral CT protocols: The importance of the spatial reconstruction

Eleftherios Lavdas, Marianna Vlychou, Violeta Roka, Greta Wozniak*, Georgia Protogerou, Ioannis Fezoulidis

Department of Radiology, University Hospital of Larissa, Medical School of Thessaly, Larissa, Greece

Received 9 May 2009; received in revised form 30 July 2009; accepted 30 September 2009

KEYWORDS
Streak artifacts;
Motion artifacts;
Segmental reconstruction

Abstract *Purpose:* This study recorded and analysed streak and motion artifacts in spiral CT examinations and evaluated the elimination and minimization of them by the use of segmental reconstruction with and without alterations of the initial examination protocol.
Materials and methods: One hundred CT scans of the chest and 300 CT scans of the brain have been included in this study. All studies were performed by a helical CT scanner (Philips 5000 SR) with the standard protocol and were randomly selected due to the presence of either streak or motion artifacts. Segmental reconstruction was applied in all cases by the same experienced radiographer. Image evaluation was performed by two experienced radiologists using a scoring system for each artifact and a grading system for classifying post-processing images.
Results: Among series of images that were evaluated after the application of segmental reconstruction, brain examinations demonstrated the following results: 10.9% of the cases showed no artifact improvement, 19.6% showed slight artifact improvement 31.5% showed moderate improvement and 38% showed significant improvement. The results of chest examinations were as follows: 27% of the cases showed no artifact improvement, 23% showed slight artifact improvement, 26% showed moderate improvement and 24% of showed significant improvement. Spatial reconstruction was useless in brain CT images when a patient moved during the entire scan and in chest CT images when streak and motion artifacts co-existed.
Conclusions: Spatial reconstruction may improve the image quality in brain and chest CT examinations and thus may contribute to more diagnostic images. Elimination of motion artifacts is also suggested due to the limitation of intravenous contrast medium that can be administered per patient per day and in cases of non-cooperative patients.

Introduction

The term «artifact» in medical imaging characterizes every deviation of the image from the exact reproduction of the anatomical and topographic characteristics of the area

* Corresponding author. Present address: Department of Radiology, University Hospital of Larissa, Mezourlo 41110, Larissa, Greece.
E-mail address: greta@med.uth.gr (G. Wozniak).

1756-1175/$36 © 2009 Euro-med Congress for Radiographers. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ejradi.2009.09.004

under examination. Artifacts can degrade the quality of the image acquired completely or partially and may simulate pathology [1,2]. Recognition and minimization or elimination of artifacts requires adequate knowledge of physics applied to scanning and reconstruction protocols [3,4].

Brain artifacts arise from the movement of the examined area during scanning that lead to images of inferior quality [4]. These artifacts would not only obscure the exact anatomical structures but also could simulate pathology such as subdural and epidural haematomas in the brain. Artifacts are often encountered in patients, who are unable to collaborate due to various clinical conditions [5—13].

Streak artifacts in chest examinations are produced by high attenuation material (i.e. metals, surgical staples, vascular calcifications, heart pacemakers), from high contrast interfaces and from cardiac motion. During the intravenous (i.v.) transmission of the contrast material in the left brachiocephalic vein or the superior vena cava, streak artifacts are produced and projected over the ascending aorta or the aortic arch and may simulate pathology such as blood clots or aortic dissections [14].

In the present study we attempted to minimize or eliminate two categories of artifacts with the method of segmental reconstruction: (a) motion artifacts in brain examinations (b) streak artifacts in thoracic aorta and pulmonary vessels during chest examinations.

Materials and methods

By the term ''segmental reconstruction'' we characterize the retrospective reconstruction process that allows reconstruction of partial images from raw data sets covering a scan angle of 270° [3,4]. Segmental reconstruction was applied in three hundred (300) brain CT examinations with motion artifacts and in one hundred (100) chest CT examinations with streak artifacts. The latter type of artifacts was observed after the i.v. injection of contrast medium with a high injection rate (>4 ml/s) that is considered optimum for imaging of great vessels. In all examinations, diagnostic problems arose due to the projection of artifacts over the normal structures.

Brain examinations were performed either by applying the conventional scanning protocol (slice width 3 mm, table shift increment 3 mm, scan time 3 s) (285/300 brain CT scans, 95%) or a fast helical scan protocol (slice collimation 3 mm, table shift increment 5 mm, scan time 1.5 s and reconstruction collimation 3 mm) (15/300 brain CT scans, 5%). Segmental reconstruction was applied in more than one slice in most of the patients. The mean ratio of all the cases is 2.6 images per patient. 82% of the processed slices have been performed with the conventional scanning protocol and the 18% of the slices with the helical scanning protocol.

The standard fast helical scan protocol for chest examinations was: slice collimation 3 mm, table shift increment 5 mm, scan time 1.5 s and reconstruction collimation 3 mm (acquisition parameters 120 Kv, 175 mA.). In all chest examinations a helical scanning protocol was applied with 2—4 images per examination and the clinical interest was focused on the imaging of the thoracic aorta and the pulmonary vessels. The pitch value in the spiral protocol for brain as well as chest examinations was 1.67 (pitch value defines the ratio of the table increment per gantry rotation to the section collimation).

The process of segmental reconstruction uses raw data sets from partial images, which cover a scan angle of 270°. Images are produced using the projections acquired after a whole X-Ray tube rotation (360°). Raw data are divided in four different segments according to the X-Ray tube rotational movement. Four sets of images are produced, each one from three different quadrants. Every image consists of contiguous projections corresponding to the continuous 270°rotational movement of the X-Ray tube and differs from the previous or the next image acquired by 90°. The same process was implemented in the chest examinations, which were performed with the use of i.v. contrast medium injection in high concentrations (350—370 mg/ml) and injection rates higher than 4 ml/s.

Two experienced radiologists performed quality evaluation. The reconstructed images were compared to the images acquired from the initial scan. At first, all artifacts included in the initially acquired images were recorded and assessed. An arbitrary scoring system (grades 1—3) was used for the assessment of the artifacts, based on the number of tissues that were blurred and the extent of the subsequent diagnostic problem. Grade 1 was given in solitary artifacts, which involved a specific area, grade 2 was given in paired artifacts or in the combination of a streak and a motion artifact that involved a more extensive region of interest and grade 3 was given in multiple artifacts that obscured extended areas of the region of interest (Table 1). After the application of segmental reconstruction in selected images, four different image categories were created:

The *first category* included patients, in whom the post-processing images acquired showed no improvement compared to the initial scan. This category corresponds to a total score of all four post-processed images less than 10% compared to the initial images.

The *second category* included patients, in whom the post-process images acquired showed minor improvement compared to the initial scan. This category corresponds to a total score of all four post-processed images ranged from 11 to 35% compared to the initial images.

The *third category* included patients, in whom the post-process images acquired showed moderate improvement compared to the initial scan. This category corresponds to a total score of all four post-processed images ranged from 36 to 70% compared to the initial images.

The *fourth category* included patients, in whom the post-process images acquired showed major improvement

Table 1 The arbitrary scoring system (grades 1—3) which was used for the assessment of artifacts.

Number of artifacts	Grading
Solitary artifact involving a specific region of interest	Grade 1
Paired or combined artifacts that involved a more extended region of interest	Grade 2
Multiple artifacts that involved extensive regions of interest	Grade 3