

COMPUTED TOMOGRAPHY – ARTIFACTS CAUSED BY PATIENT

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Abstract: One of explain what is the artifact in science and technology is artifact (error) than misleading or confusing alteration in data or observation, commonly in experimental science, resulting from flaw in technique or equipment. Artifacts can significantly interfere the quality of CT images to such an extent that they are useless for diagnosis. For the needs of optimizing image quality, it is necessary to understand why artifacts arise and how is it possible to prevent from them. In CT the notion artifact is applied on any systematic non-conformity between CT numbers in a reconstructed image and real coefficients of attenuating of scanned object. In this article we describe some artifacts caused by patient.

1 Artifacts of CT displaying

Artifact uses in computing (software development), means one of many kinds of tangible byproducts produced during the development of software. Exists virtual artifact, which we can describe than an object in a digital environment.

There are many reasons for CT artifacts formation. Physical artifacts come from physical process involved in acquisition of CT data. Artifacts caused by patient are induced by moving of patient or by the presence of metal objects on patient. Artifacts caused by scanner are the consequence of imperfection in scanner function. Artifacts of spiral and multi-slice technique are caused by the display reconstruction process. Construction elements incorporated into existing CT scanners minimize such artifacts which can sometimes be partly corrected by the software of scanner.

In spite of this in many cases careful positioning of patient and optimal parameter selection of scanning are the most significant factors to prevent from CT artifacts. CT image in its nature is more prone to artifacts than conventional X-ray image, because the image is reconstructed of millions of independent detector measurements. The reconstruction technique assumes that all the measurements are correct so any defective measurements are normally reflected as an error in reconstructed image [1,2].

2 Artifacts caused by patient

2.1 Metal artifacts

The presence of metal objects in scanned area can cause strong striped artifacts. The density of metal is out of normal extent of the computer so that partial profiles of weakness are obtained. Additional artifacts as a result of beam hardening, partial volume and aliasing are a serious problem when scanning very dense objects.

Prevent metal artifacts service. Before scanning patients are asked to remove all removable metal objects such as jewels. It is possible to avoid unremovable objects such as dental fillings, prosthetic devices and surgical clips by lean of gantry so that metal parts do not interfere scanned part of the body. If impossible to modify required scanned part in order to avoid metal objects, the technical change mainly increasing in kilovolts can help the beam to penetrate through some objects more efficiently. The ratio of artifact partial volume is reduced by using of thinner cuts.

Software correction of metal artifacts. The striping caused by exceeding extent can be largely reduced by using of special software. Producers use various interpolating techniques due to replacing figures of excessive extent in profiles of weakness. Effectiveness of one of these techniques is viewed in Figure 1. However, the usefulness of the cutdown metal artifact software is sometimes restricted because although striped artifacts are removed from metal implants there is a loss of details around interface metal – tissue what is often the area of diagnosis interest. The software for correction of beam hardening should be used when scanning metal objects to minimize additional artifacts as a result of beam hardening [3].

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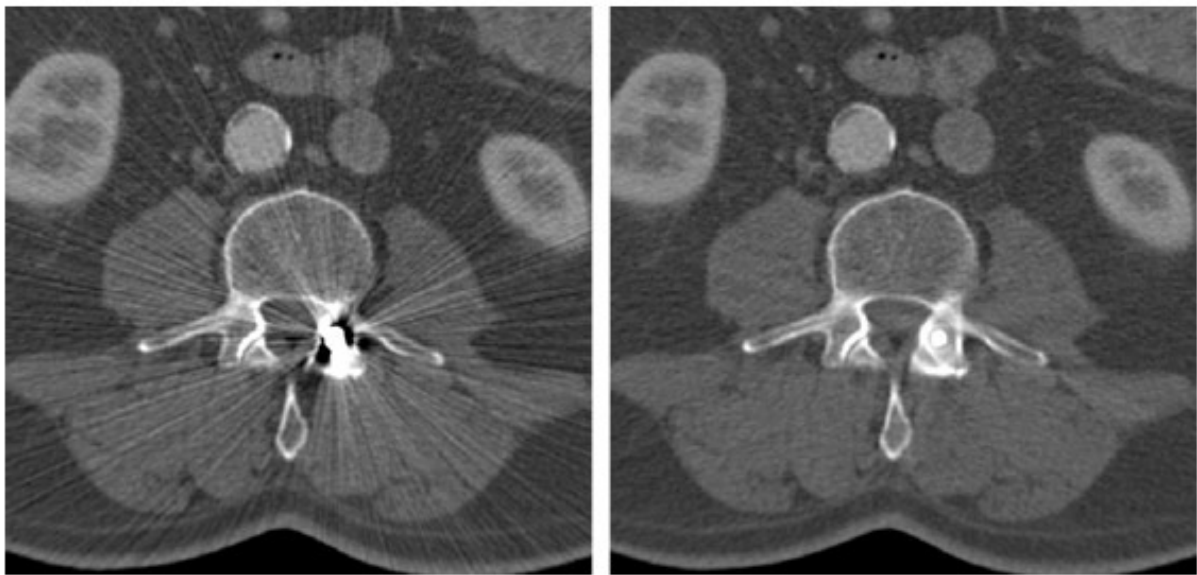


Figure 1 CT images of patient with metal implants in spine. Left displaying without correction and right with metal artifact cutdown [4].

2.2 Patient's moving

Patient's moving can cause artifacts of wrong registration which eventually occur as shades or stripes in displayed image (Figure 2).



Figure 2 CT image of head showing moving artifacts [2].

Steps can be carried out to prevent from free movement though during scanning it is sometimes impossible to avoid free movement. However additional devices exist for some scanners designed in order to minimize these artifacts.

Prevent moving artifacts service. Using positioning device is adequate to prevent from unwanted moving in most patients. In spite of this in some cases (e.g. children) it is inevitable to immobilize patients via sedation. Using the

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shortest scan time helps minimize these artifacts when scanning the area prone to move. It is possible to minimize respiratory movement if patient is able to hold breath while scanning. Sensitivity of image on moving artifacts depends on moving orientation. That's why it is better if starting and final position of X-ray lamp is in direction with primary movement, e.g. vertical above or under the patient when scanning thorax. Special mode of body scanning unlike head scanning mode can automatically have added a reduction of moving artifacts in displaying.

Built-in functions for minimizing of moving artifacts. Producers minimize moving artifacts by using of excessive and partial scanning mode, software correction and cardiac gating (see below).

Excessive and partial scanning mode: Maximum discrepancies in detector measurements occur between projections obtained in starting and final 360° scan.

Some types of scanners use excessive scanning mode for axial scans where 10% is added to standard 360° scan. Repeated projections are averaged what helps cutdown moving artifacts. Using partial scanning mode is also available for cutdown moving artifacts though it can result in a weaker distinction.

Software correction: Most scanners when body scanning automatically apply reduced balancing in starting and final projection in order to inhibit their contribution to the final image. However, it can result in increasing of rustle in final image in vertical direction depending on patient's shape.

Some scanners have also special moving correction. The efficiency of one of these methods which correct artifacts as a result of moving on the interface of liquid is viewed in Figure 3.

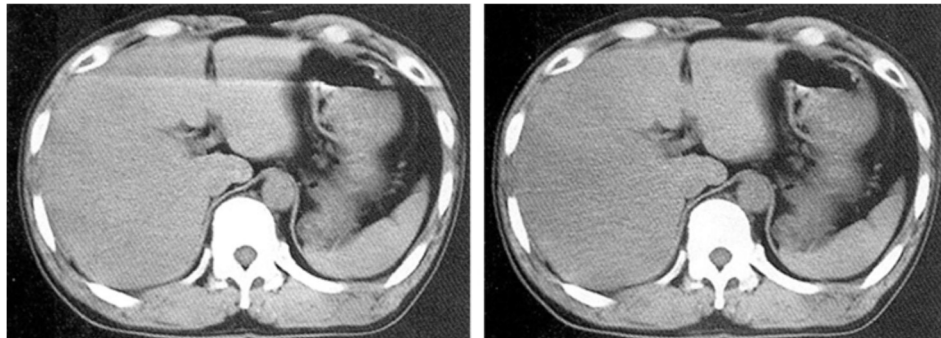


Figure 3 CT images of body with moving correction. Left made with conventional displaying and right with moving artifact correction [5].

Cardial gating: Fast heart movements can result in characteristic artifacts in heart images and these artifacts can imitate a disorder in outlying structures, e.g. aortic dissection. In order to eliminate these problems new techniques were developed which use data only from a part of heart action to create images. It is achieved by combination of electrocardiographic gating techniques with special methods of image displaying [3].

2.3 Partial projections

If a part of patient's body lies out of scanned field of view the computer has partial information about this part and striped and shade artifacts occur. This is viewed in Figure 4 which shows a patient scanned with upper limbs placed along the body instead of raising them out of scanning extent. If upper limbs are placed out of scanned field of view they are not present in the image but their presence in some projection when scanning leads to such serious artifacts in the image that significantly degrade their using. Similar effects can be evoked by dense objects such as intravenous tube containing contrast medium lying

out of scanned field. Blocking reference canals on the side of beam detectors can also interfere with normalization of data and cause striped artifacts [2].



Figure 4 CT image with striped artifacts. CT image of body of patient with upper limbs along the body but out of scanned area what causes striped artifacts (Radiology Department).

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In order to prevent from artifacts due to partial projections it is inevitable to position patient so that any part of the body does not lie out of the scanned field. Scanners designed for planning radiation therapy have larger holes and larger scanned field and they allow greater extent in patient positioning. It also allows to scan extremely enormous patients who cannot fit in the hole of normal scanners. Some producers monitor reference data canals to obtain discrepancies and if these reference data seem to be suspicious they avoid using them [2].

Conclusion

In medical viewing artifacts represent wrong displaying of tissue structures in medical images performed by such imaging modalities as ultrasonography, computed tomography and magnetic resonance imaging. These artifacts are caused by various phenomena such as physical effect between tissue and energy, error receiving data when patient moving or reconstruction algorithms unable to represent anatomy. It is necessary to recognize these artifacts, which can cover or pretend pathological image. For correct interpretation of diagnostic images, it is inevitable to understand the principle of particular diagnostic methods and the principle of formation of their artifacts [6]. This summary is a continuation of articles about mentioned artifacts in ultrasonography [7] and magnetic resonance [8,9].

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