

ANSWERS TO REVIEWERS



September 20, 2013

Dear Editor,

Please find enclosed the edited manuscript in Word format (file name: AJE_Edited_ManuscriptWJR_Rev_edited_finalLH).

Name of Journal: World Journal of Radiology

ESPS Manuscript No: 4710

Title: CT dose and image quality in the last three scanner generations (new revised title)

Comparison of CT dose and image quality with filtered back projection, iterative reconstruction and CT with a new detector with minimal electronic noise (old title)

Authors (typed): Andreas Christe, Johannes Heverhagen, Christoph Ozdoba, Christian Weisstanner, Stefan Ulzheimer, Lukas Ebner

The manuscript has been improved according to the suggestions of reviewers:

1 Format has been updated

2 Revision has been made according to the suggestions of the reviewer (changes are highlighted in yellow in the revised manuscript)

(1) Title was shortened to 11 words from

“Comparison of CT dose and image quality with filtered back projection, iterative reconstruction and CT with a new detector with minimal electronic noise”

to

“CT dose and image quality in the last three scanner generations”

(2) A running title was introduced: CT dose and image quality

(3) Authors, authors department and contribution as well as the correspondence was listed:

Andreas Christe, Johannes Heverhagen, Christoph Ozdoba, Christian Weisstanner, Stefan Ulzheimer, Lukas Ebner

Andreas Christe, Johannes Heverhagen, Lukas Ebner, Department of Radiology, University Hospital of Bern, Inselspital, Freiburgstrasse 10, 3010 Bern, Switzerland

Christoph Ozdoba, Christian Weisstanner, Department of Neuroradiology, University Hospital of Bern, Inselspital, Freiburgstrasse 10, 3010 Bern, Switzerland

Stefan Ulzheimer, Siemens AG Healthcare, An der Lände 1, 91301 Forchheim, Germany

Author contributions: Ebner L and Christe A performed the majority of the experiments. Ozdoba C, and Weisstanner C coordinated the experiments with the Somatom Definition Edge Scanner and were also involved in editing the manuscript. Ulzheimer S and Heverhagen J performed the physical, mathematical and technical review and edited the manuscript. Christe A and Ebner L designed the study and wrote the manuscript.

Correspondence to

Andreas Christe, MD; Departement of Radiology, University Hospital of Bern Inselspital, Freiburgstrasse 10, 3010 Bern, Switzerland, andreas.christe@insel.ch

Telephone: +41-31-6321965,

Fax: +41-31-6324874

(4) The results section of the abstract was extended to more than 150 words:

RESULTS: When using iterative reconstruction (IR) instead of filtered back projection (FBP), the average dose reduction was 30%, 52% and 80% for bone, soft tissue and air, respectively, for the same image quality (p-value < 0.0001). The recently introduced Stellar detector (Sd) lowered the radiation dose by an additional 27%, 54% and 70% for bone, soft tissue and air, respectively (p-value < 0.0001). The benefit of dose reduction was larger at lower dose levels. With the same radiation dose, an average of 34% (22% - 37%) and 25% (13% - 46%) more contrast to noise was achieved by changing from FBP to IR and from IR to Sd, respectively. For the same contrast to noise level, an average of 59% (46% - 71%) and 51% (38% - 68%) dose reduction was produced for IR and Sd, respectively. For the same subjective image quality, the dose could be reduced by 25% (2 - 42%) and 44% (33 - 54%) using IR and Sd, respectively.

(5) Core tip was implemented:

A CT dose reduction between 30% and 80% can be expected when using iterative reconstruction instead of filtered back projection. The benefit of dose reduction is larger at lower dose levels. An additional dose reduction between 27% and 70% can be obtained by applying the new Stellar detector.

(6) Comments were added:

COMMENTS

Background

Due to increasing computing capacity, iterative image reconstruction can be introduced into clinics, leading to the potential for dose reduction by replacing older filtered back projection methods. The problem of electronic noise during image acquisition was overcome by integrating the analog-digital-converter with the photodiode of the CT-detectors on the same silicon chip. This noise reduction can either be used for dose reduction or to increase the image quality. The three latest CT-scanner generations were examined to compare their potential for dose reduction.

Research frontiers

Several studies demonstrated the feasibility of low dose imaging without loss of sensitivity for pulmonary diseases. Radiologists are able to lower the CT tube current and/or the tube voltage, using the lowest acceptable published dose levels for older CT scanners. Manufacturer dependent progress in CT-technology was only partly investigated. Dose or noise reduction using iterative reconstruction has been published, but the potential for new detectors in the clinic is not yet known.

Innovations and breakthroughs

This study demonstrates the dependency of CT radiation dose, image quality and CT-generation. It is possible to obtain the same image quality with a dose reduction of 30% to 80% by substituting filtered back projection with iterative image reconstruction. Using the new CT-detectors, radiation dose can be reduced by an additional 27% to 70%, depending on the scanned tissue.

Applications

With our results, the lowest acceptable tube currents and voltages for the older CT-generations can be transferred to the newest scanners.

Terminology

CT-exams produce cross sectional images of the body, based on the radiation absorption of the body tissues. Radiation absorption is measured at every angle circularly around the body and is back-projected on a virtual pixel field in the scanned plane, delivering a filtered back projection image. New iterative reconstruction methods distribute the absorption of one angle to all of the pixels in a direction, adjusting the pixel values based on the effective absorption for each angle position. For clinical routines, three iterations of 360° rotation are used, which is very time-consuming. Only recently was it possible to deliver sufficient computing power for these clinical scanners.

(7) Table 1 is newly provided in word format for editing

3 References and typesetting were corrected.

The manuscript was edited for proper English language, grammar, punctuation, spelling, and overall style by editors at American Journal Experts (corrections are highlighted). The Certificat of the American Journal Experts is attached.

Thank you again for publishing our manuscript in the *World Journal of Radiology*.

Sincerely yours,

A handwritten signature in blue ink, appearing to read 'A. Christe'.

PD Dr. med. Andreas Christe
INSELSPITAL, Hospital and University of Bern
Department of Radiology
Freiburgstrasse 10
3010 Bern
Switzerland

+41 (0)31 632 19 65

andreas.christe@hotmail.com