

## Aquilion ONE Clinical Evidence: Low Dose

### FIRST

#### [Chest CT Scan at Radiation Dose of a Posteroanterior and Lateral Chest Radiograph Series: A Proof of Principle in Lymphangiomyomatosis](#)

*Eileen Hu-Wang, John L. Schuzer, Shirley Rollison, Eric S. Leifer, Chloe Steveson, Vissaagan Gopalakrishnan, Jianhua Yao, Tania Machado, Amanda M. Jones, Patricia Julien-Williams, Joel Moss, Marcus Y. Chen*

Chest. 2019 Mar;155(3):528-533

- A low dose chest CT scan reconstructed with FIRST provides similar cyst score quantification as standard dose CT scan. 96% dose reduction from a clinical dose scan

#### [Effects of reconstruction technique on the quality of abdominal CT angiography: A comparison between forward projected model-based iterative reconstruction solution \(FIRST\) and conventional reconstruction methods](#)

*Rongli Wu, Masatoshi Hori, Hiromitsu Onishi, Atsushi Nakamoto, Hideyuki Fukui, Takashi Ota, Takuya Nishida, Yukihiro Enchi, Kazuhiko Satoh, Noriyuki Tomiyama*

European Journal of Radiology 106 (2018) 100–105

- FIRST reconstruction can significantly improve image quality and provide better delineation of peripheral abdominal artery structures compared with its predecessors, AIDR 3D and FBP. The superior quality of images acquired using FIRST was evaluated and confirmed both objectively and subjectively

#### [Neointimal formation after carotid artery stenting: phantom and clinical evaluation of model-based iterative reconstruction \(MBIR\)](#)

*Kazushi Yokomachi, Fuminari Tatsugami, Toru Higaki, Shinji Kume, Shigeyuki Sakamoto, Takahito Okazaki, Kaoru Kurisu, Yuko Nakamura, Yasutaka Baba, Makoto Iida, Kazuo Awai*

Eur Radiol. 2019 Jan;29(1):161-167

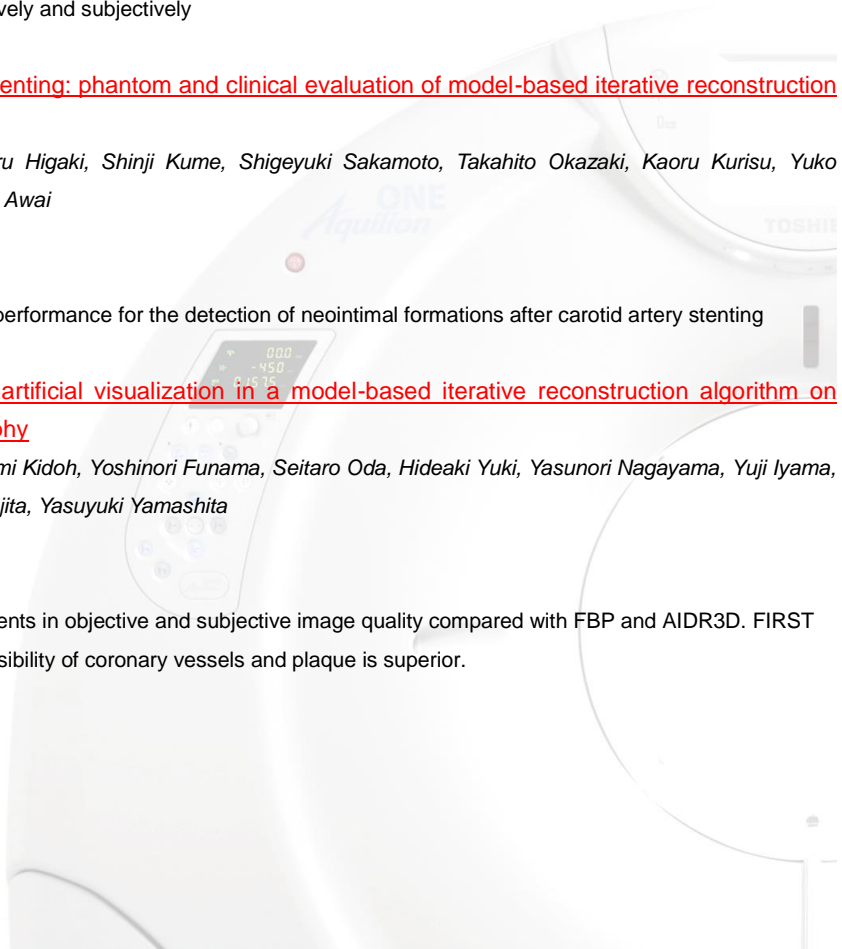
- FIRST helped to improve diagnostic performance for the detection of neointimal formations after carotid artery stenting

#### [Tradeoff between noise reduction and artificial visualization in a model-based iterative reconstruction algorithm on coronary computed tomography angiography](#)

*Kenichiro Hirata, Daisuke Utsunomiya, Masafumi Kidoh, Yoshinori Funama, Seitaro Oda, Hideaki Yuki, Yasunori Nagayama, Yuji Iyama, Takeshi Nakaura, Daisuke Sakabe, Kenichi Tsujita, Yasuyuki Yamashita*

Medicine (2018) 97:20(e10810)

- FIRST provides significant improvements in objective and subjective image quality compared with FBP and AIDR3D. FIRST reduced image noise and structure visibility of coronary vessels and plaque is superior.



[Improved Estimation of Coronary Plaque and Luminal Attenuation Using a Vendor-specific Model based Iterative Reconstruction Algorithm in Contrast-enhanced CT Coronary Angiography](#)

*Yoshinori Funama, Daisuke Utsunomiya, Kenichiro Hirata, Katsuyuki Taguchi, Takeshi Nakaura, Seitaro Oda, Masafumi Kidoh, Hideaki Yuki, Yasuyuki Yamashita*

Acad Radiol, 2017, DOI: 10.1016/j.acra.2017.02.006

- This phantom and limited patient study showed that FIRST reduces the plaque density and lumen to plaque contrast, therefore improving visualization of coronary plaques in CTA

[Coronary Artery Stent Evaluation with Model-based Iterative Reconstruction at Coronary CT Angiography](#)

*Fuminari Tatsugami, Toru Higaki, Hiroaki Sakane, Wataru Fukumoto, Yoko Kaichi, Makoto Iida, Yasutaka Baba, Masao Kiguchi, Yasuki Kihara, So Tsushima, Kazuo Awai*

Acad Radiol, 2017, DOI: 10.1016/j.acra.2016.12.020

- Image quality of coronary artery stent CT scans was better on FIRST images than on AIDR 3D images. Diagnostic performance may be improved when the FIRST algorithm rather than the AIDR 3D algorithm is applied for the detection of in-stent re-stenosis.

[Effects of Iterative Reconstruction Algorithms on Computer-assisted Detection \(CAD\) Software for Lung Nodules in Ultra-low-dose CT for Lung Cancer Screening](#)

*Yukihiko Nomura, Toru Higaki, Masayo Fujita, Soichiro Miki, Yoshikazu Awaya, Toshio Nakanishi, Takeharu Yoshikawa, Naoto Hayashi, Kazuo Awai*

Acad Radiol, 2016, DOI: 10.1016/j.acra.2016.09.023

- This paper describes ultra low dose lung CT reconstructed with FIRST and AIDR 3D, compared with low dose lung CT reconstructed with FBP to detect lung nodules with CAD. The results showed that ULD with FIRST has similar accuracy to LD with FBP to detect lung nodules.

[Lung cancer screening with ultra-low dose CT using full iterative reconstruction.](#)

*Fujita M, Higaki T, Awaya Y, Nakanishi T, Nakamura Y, Tatsugami F, Baba Y, Iida M, Awai K.*

Jpn J Radiol. 2017 Apr;35(4):179-189

- This paper describes ultra low dose lung CT reconstructed with FIRST, compared with low dose lung CT reconstructed with FBP to detect lung nodules. The results showed that ULD with FIRST has similar accuracy to LD with FBP to detect lung nodules in small patients.

[Pediatric 320-row cardiac computed tomography using electrocardiogram-gated model-based full iterative reconstruction.](#)

*Shirota G, Maeda E, Namiki Y, Bari R, Ino K, Torigoe R, Abe O*

Pediatr Radiol. 2017 Oct;47(11):1463-1470.

- Compared with AIDR 3D enhanced, FIRST provides better depiction with 320-row pediatric cardiac CT. Image quality of low-dose cardiac CT reconstructed with ECG-gated MBIR is clinically acceptable for children. Mean Radiation Dose = 0.37mSv

[The feasibility of Forward-projected model-based Iterative Reconstruction SoluTion \( FIRST \) for coronary 320-row computed tomography angiography : A pilot study](#)

Maeda E, Tomizawa N, Kanno S, Yasaka K, Kubo T, Ino K, Torigoe R, Ohtomo K  
J Cardiovasc Comput Tomogr. 2017 Jan - Feb;11(1):40-45

- FIRST is compared to AIDR3D reconstruction for coronary CTA scanned on Aquilion ONE ViSION Edition. FIRST allowed 28% dose reduction while improving image quality. Despite reduced radiation exposure, blooming artifacts, image sharpness, image noise, and overall image quality were significantly better with FIRST.

[Comparative evaluation of newly developed model-based and commercially available hybrid-type iterative reconstruction methods and filter back projection method in terms of accuracy of computer-aided volumetry \( CADv \) for low-dose CT protocols in phantom](#)

Ohno Y, Yaguchi A, Okazaki T, Aoyagi K, Yamagata H, Sugihara N, Koyama H, Yoshikawa T, Sugimura K  
European Journal of Radiology 85 (2016) 1375–1382

- Different sized lung nodules and HU were used in this phantom study. Recon thickness was 1mm superiority of FIRST and AIDR3D were shown compared to FBP. Dose reduction of more than 85% can be achieved using FIRST reconstruction

## **AIDR 3D**

[Association of Focal Radiation Dose Adjusted on Cross Sections with Subsolid Nodule Visibility and Quantification on Computed Tomography Images Using AIDR 3D: Comparison Among Scanning at 84, 42, and 7 mAs](#)

Yukihiro Nagatani, Hiroshi Moriya, Satoshi Noma, Shigetaka Sato, Shinsuke Tsukagoshi, Tsuneo Yamashiro, Mitsuhiro Koyama, Noriyuki Tomiyama, Yoshiharu Ono, Sadayuki Murayama, Kiyoshi Murata, for the Investigators of ACTive Study Group  
Acad Radiol. 2018 Sep;25(9):1156-1166

- Comparable quantification was demonstrated irrespective of doses for larger sub solid nodules. For smaller sub solid nodules, nodular exaggerating effect associated with decreased SSDE on CT at 7 mAs compared to 84 mAs could result in comparable visibilities to CT at 42 mAs

[Comparison of computer-aided detection \(CADE\) capability for pulmonary nodules among standard-, reduced- and ultra-low-dose CTs with and without hybrid type iterative reconstruction technique](#)

Yoshiharu Ohno, Kota Aoyagi, Qi Chen, Naoki Sugihara, Tae Iwasawa, Fumito Okada, Takatoshi Aoki  
European Journal of Radiology 100 (2018) 49–57

- The reconstruction algorithm has a significant beneficial effect on the nodule detection capability of the CADE system when attempts are made to improve image quality at reduced- and ultra-low radiation dose of chest CT examinations.
- In addition, with the AIDR 3D method in conjunction with the CADE system, the radiation dose of CT examinations can be reduced without any degradations of image quality and detection performance.

[The impact of dose reduction on the quantification of coronary artery calcifications and risk categorization: A systematic review](#)

*Vonder M, van der Werf N, Leiner T, Greuter M, Fleischmann D, Vliegenthart R, Oudkerk M, Willemink M*

JCCT, 2018, DOI:10.1016/j.jcct.2018.06.001

- The impact of AIDR 3D and tube current reduction was examined in five studies, including two phantoms and 441 patients.
- Radiation doses of the full dose protocols ranged from 4.1 to 16.1 mGy and reduced to radiation doses ranging from 0.7 to 5.7 mGy with a reclassification of 5%–11% when AIDR 3D was used.

[Low Radiation Dose Calcium Scoring: Evidence and Techniques](#)

*Kaitlin B. Baron, Andrew D. Choi, Marcus Y. Chen*

Curr Cardiovasc Imaging Rep (2016) 9: 12

- This review article shows that we have an increasing body of evidence on multiple platforms that CAC scoring at sub-mSv radiation doses can be performed reliably, particularly through the use of iterative reconstruction.
- Thus, the present literature supports coronary calcium scoring at radiation doses that allow for cardiac risk categorization lower than for screening in other diseases.

[Improvement of image quality and dose management in CT fluoroscopy by iterative 3D image reconstruction](#)

*Grosser Oliver S; Wybranski Christian; Kupitz Dennis; Powerski Maciej; Mohnike Konrad; Pech Maciej; Amthauer Holger; Ricke Jens*

European Radiology, 2017 Sep;27(9):3625-3634

- Details reduction in radiation dose during CT interventional procedures accompanied with decreased image noise and increased reader confidence. Effective dose for abdominal biopsies reduced by approximately 50% and for brachytherapy catheters in the liver 60% thanks to AIDR 3D

[Low-Dose Pelvic Computed Tomography Using Adaptive Iterative Dose Reduction 3-Dimensional Algorithm : A Phantom Study](#)

*Onishi Hiromitsu, Kockelkoren Remko, Hori Masatoshi, Nakamoto Atsushi, Tsuboyama Takahiro, Sakane Makoto, Tatsumi Mitsuaki, Uranishi Ayumi, Tomiyama Noriyuki*

J Compt Assist Tomography, epub ahead of print

- This study used both qualitative and quantitative image quality assessment tools to evaluate the dose reduction capability of AIDR 3D. The Catphan phantom based AUC results showed a dose reduction of 50%.

[Adaptive iterative dose reduction 3D \(AIDR 3D\) vs. filtered back projection: radiation dose reduction capabilities of wide volume and helical scanning techniques on area-detector CT in a chest phantom study](#)

*Shinichiro Seki, Hisanobu Koyama, Yoshiharu Ohno, Sumiaki Matsumoto, Hiroyasu Inokawa, Naoki Sugihara, Kazuro Sugimura*

Acta Radiologica, Epub ahead of print

- The study showed that AIDR 3D can be used for lung screening without affecting the ability to identify nodules, including GGO, semi-solid nodules

[Radiation dose reduction for coronary artery calcium scoring at 320-detector CT with adaptive iterative dose reduction 3D](#)

*Tatsugami Fuminari; Higaki Toru; Fukumoto Wataru; Kaichi Yoko; Fujioka Chikako; Kiguchi Masao; Yamamoto Hideya; Kihara Yasuki; Awai Kazuo*

The International Journal of Cardiovascular Imaging, 2015, epub ahead of print

- The mean effective radiation dose for routine- and low-dose CT was 2.2 and 0.7 mSv, respectively. The use of AIDR 3D made it possible to reduce the radiation dose by 67 % for CAC scoring without impairing the quantification of coronary calcification

[The Impact of Different Levels of Adaptive Iterative Dose Reduction 3D on Image Quality of 320-Row Coronary CT Angiography: A Clinical Trial](#)

*Feger Sarah; Rief Matthias; Zimmermann Elke; Martus Peter; Schuijf Joanne Désirée; Blobel Jörg; Richter Felicitas; Dewey Marc*  
*PlosOne, 2015, 10(15): e0125943*

- On standard-dose coronary CTA images, AIDR 3D strong showed higher objective image quality than FBP/QDS without reducing contour sharpness.

[Diagnostic Performance and Dose Comparison of Filtered Back Projection and Adaptive Iterative Dose Reduction Three dimensional CT Enterography in Children and Young Adults](#)

*Daniel B. Wallihan, Daniel J. Podberesky, John Sullivan, Lee A. Denson, Bin Zhang, Shelia R. Salisbury, Alexander J. Towbin*

Radiology 2015, Epub ahead of print

- Reduced-dose CT enterography with AIDR 3D allowed substantial dose reduction compared with that used with FBP CT enterographic examinations, while maintaining a high diagnostic performance

[Computed tomography angiography of carotid and coronary artery via a single-bolus injection protocol: a feasibility study using 320-row multidetector CT](#)

*WeiGuo Zhang, Hang Jin, Gang Chen, Wenfang Chen, Junying Gu, Mengsu Zeng*

*Eur Radiol (2014) 24:1628–1635*

- Excellent example of the dose lowering capabilities of AIDR3D. The paper demonstrates that AIDR3D in conjunction with lower kV's can produce superior image quality to FBP.

[Initial Experience with Adaptive Iterative Dose Reduction 3D to Reduce Radiation Dose in Computed Tomographic Urography](#)

*Juri H, Matsuki M, Ito Y, Inada Y*

*J Comput Assist Tomogr 2013;37: 52Y57*

- This is a prospective study comparing low dose CT Urography (Excretory Phase) with FBP compared to the exact same scan on the same patients performed with AIDR 3D mild with an automated 50% dose reduction in combination with SUREExposure. The AIDR 3D scans showed superior or equal image quality with an average dose reduction of 45%. The average AIDR 3D dose was a respectable 3.09 mSv which is less than half the recommended dose according to the ESUR guidelines. In addition, a clear explanation of the AIDR 3D algorithm is provided.

Simulated 50 % radiation dose reduction in coronary CT angiography using adaptive iterative dose reduction in three-dimensions (AIDR3D).

Chen, Marcus Y, Steigner, Michael L, Leung, Steve W, Kumamaru, Kanako K, Schultz, Kurt, Mather, Richard T, Arai, Andrew E, Rybicki, Frank J.

International Journal of Cardiovascular Imaging, 2013, epub ahead of print.

- Simulated radiation dose reduction applied to clinical coronary CTA images suggests that a 50 % reduction in radiation dose can be achieved with adaptive iterative dose reduction software with image quality that is at least comparable to images acquired at standard radiation exposure and reconstructed with filtered back projection.

Adaptive Iterative Dose Reduction Using 3D Processing for Reduced- and Low-Dose Pulmonary CT: Comparison With Standard-Dose CT for Image Noise Reduction and Radiological Findings.

Ohno Y, Takenaka D, Kanda T, Yoshikawa T, Matsumoto S, Sugihara N, Sugimura K,

AJR, 2012, 199; 4:w477-85

- Accuracy to detect emphysema, ground-glass opacity, bronchiectasis, honeycomb pattern, and nodules were assessed. Results show no difference in diagnostic performance or image quality with the reduced dose images with a dose reduction of 66% with AIDR 3D.

Dose reduction in chest CT: Comparison of the adaptive iterative dose reduction 3D, adaptive iterative dose reduction, and filtered back projection reconstruction techniques.

Yamada Y, Jinzaki M, Hosokawa T, Tanami Y, Sugiura H, Abe T, Kuribayashi S

European Journal of Radiology, Aug 2012

- This is an excellent paper validating AIDR 3D in achieving a 64.2% dose reduction for routine chest examinations using automatic exposure control. The mean dose for the scans acquired with AIDR 3D integrated into <sup>SURE</sup>Exposure was a respectable 1.23 mSv, compared to scans performed without AIDR 3D with an AEC dose of 3.43 mSv in the same patients.

The effect of adaptive iterative dose reduction on image quality in 320-detector row ct coronary angiography.

Tatsugami F, Matsuki M, Nakai G, Inada Y, Kanazawa S, Takeda Y, Morita H, Takada H, Yoshikawa S, Fukumura K, Narumi Y.

Br J Radiol. 2012 Jan 17. Epub ahead of print

- This paper used data from 50 patients reconstructed with FBP and AIDR+. Results show highly significant differences in image quality and improved segment image quality with AIDR+. Image noise was reduced by 42% while CNR improved 70% when comparing FBP to AIDR+. The authors clearly articulate the limitations of the study as well as explaining the positive impact of their work on reducing patient dose using the 320-row unit.

[Lung Image Quality with 320-row Wide-volume CT Scans: The Effect of Prospective ECG-gating and Comparisons with 64-row Helical CT Scans.](#)

*Yamashiro, Tsuneo and Miyara, Tetsuhiro and Takahashi, Masashi and Kikuyama, Ayano and Kamiya, Hisashi and Koyama, Hisanobu and Ohno, Yoshiharu and Moriya, Hiroshi and Matsuki, Mitsuru and Tanaka, Yuko and Noma, Satoshi and Murayama, Sadayuki*  
Academic radiology, 2012, Epub ahead of print

- This paper clearly shows that ECG gated wide volume scanning of the chest provides superior image quality compared to conventional 64 row helical scanning at NO additional dose. The Aquilion ONE is the only system that can provide this solution as gated acquisition on conventional CT systems is not feasible due to a 3-4 increase in radiation dose with gated helical scanning.

[CT image quality improvement using adaptive iterative dose reduction with wide-volume acquisition on 320-detector CT.](#)

*Gervaise A, Osemont B, Lecocq S, Noel A, Micard E, Felblinger J, Blum A*  
European Radiology, 2012, 22(2):295-301

- The article compares the effect of AIDR, mainly on noise, using both a phantom study and a small (n=15) lumbar spine study. Noise reduction of 40% and a dose reduction of 52% in the lumbar spine scans.

[Investigation of lung nodule detectability in low-dose 320-slice computed tomography](#)

*Silverman, J. D. and Paul, N. S. and Siewerdsen, J. H.*  
Medical Physics, 2009, 36(5):1700

- Nice phantom analysis of optimal low dose lung protocol. This study is particularly useful to customers interested in lowering chest protocol doses and those asking about protocols for lung screening. It is a good demonstration that actual lung screening doses can be much lower than those used in NLST which used protocols not optimized for dose.

[Image Quality in Reduced-Dose Coronary CT Angiography.](#)

*Gagarina NV, Irwan R, Gordina G, Fominykh E, Sijens PE.*  
Acad Radiol, 2011, 18:984-990

- A 100kV scan protocol provides a mean dose reduction of 80%, from 4.9 to 0.98 mSv with no significant loss of visual image quality. Patients with a BMI less than 30 were included in the study.

[Low-dose triple-rule-out using 320-row-detector volume MDCT - less contrast medium and lower radiation exposure.](#)

*Durmus T, Rogalla P, Lembcke A, Muhler M, Hamm B, Hein P.*  
European Radiology, 2011, 21(7):1416-23

- This is a well written examination of a novel triple-rule-out (TRO) protocol designed on the Aquilion ONE. They used a volume acquisition, prospectively gated cardiac scan at 100 kV for the coronary portion and a 2 acquisition, wide-volume scan for the chest. Together, these resulted in a total effective dose of between 2 and 3.3 mSv. The contrast injection protocol was optimized for this new scan technique.

Direct Quantification of Breast Dose During Coronary CT Angiography and Evaluation of Dose Reduction Strategies.

Abadi S, Mehrez H, Ursani A, Parker M, Paul N

AJR. American Journal of Roentgenology, 2011 Feb, 196(2):152-8

- Review of breast doses in Cardiac CTA and the various scan techniques. Volume scanning has 40% dose reduction when compared to helical without modulation.
- 

Reduced exposure using asymmetric cone beam processing for wide area detector cardiac CT.

Bedayat A, Rybicki F, Kumamaru K, Powers S, Signorelli J, Steigner M, Steveson C, Soga S, Adams K, Mitsouras D, Clouse M, Mather R

The International Journal of Cardiovascular Imaging, 2011

- This is a simple but good study that explains the asymmetric cone beam processing for cardiac scanning and validates the associated dose reduction. The authors show a 24% dose reduction in patients with no significant change in image quality.

Prospective Gating With 320-MDCT Angiography: Effect of Volume Scan Length on Radiation Dose.

Khan A, Nasir K, Khosa F, Saghir A, Sarwar S, Clouse M

AJR. American Journal of Roentgenology 2011; 196:407–411

- Substantial dose reduction can be achieved by reducing volume scan length so that it is in concert with the patient's heart length. The median radiation dose was reduced 33% when the volume scan length was changed to 140 mm and 47% when the length was changed to 120 mm.

Scan time and patient dose for thoracic imaging in neonates and small children using axial volumetric 320-detector row CT compared to helical 64-, 32-, and 16- detector row CT acquisitions.

Kroft L, Roelofs J, Geleijns J

Pediatric Radiology, 2010 March, 40(3):294-300

- A phantom study comparing dose and scan time for various scan modes. Shows that volumetric scanning significantly reduces scan time and can reduce radiation dose when compared to 16 and 64 slice helical scan modes.