Publications with ASiR™

(Advanced Statistical iterative Reconstruction)

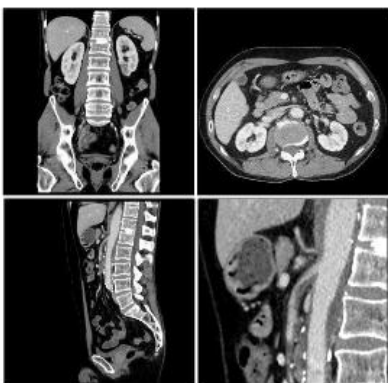RSNA '09
RSNA '10
ECR '10
ECR '11
SPIE '10
SPIE '11

Content

CHEST IMAGING

RSNA 09

Adaptive Statistical Iterative Reconstruction for Dose Reduction in Chest CT

Sarabjeet Singh, MBBS – Abstract Co-Author, Mannudeep Kalra, MD, Jiang Hsieh, PhD, Homer Pien, PhD, Jo-Anne Shepard, MD, Subba Digumarthy, MD (MGH, GE)

PURPOSE: To evaluate radiation dose reduction and image quality for chest CT reconstructed using Adaptive Statistical iterative Reconstruction (ASIR).

METHOD AND MATERIALS:
In an IRB approved prospective randomized clinical study, 19 patients (mean age 63.4 ± 8.1 years, M:F 10:9) gave informed consent for acquisition chest CT data at standard (120 kVp, 200 mAs) and three levels of radiation dose reduction (120 kVp, 150, 100, 50 mAs) on 64 slice MDCT (GE Discovery CT750 HD). Standard and low dose CT images were obtained at same anatomical region through the smallest chest lesion. 2.5 mm images were reconstructed using ASIR. Two thoracic radiologists independently graded subjective image noise, lesion conspicuity, diagnostic acceptability and visibility of small structures in lung and mediastinum using five-point scale (1= excellent, 5= unacceptable). Transverse diameter and weights were recorded for each patient. Objective image noise and CT numbers were measured in descending aorta. Data were analyzed using analysis of variance and Wilcoxon signed rank test.

RESULTS:
Objective noise in chest CT images with standard dose and reduced (25%, 50%, 75%) dose level were 11.2 ± 3.5 and 13.3 ± 3.7, 16.2 ± 4.3, 20.3 ± 6.5 respectively. **Subjective image noise was rated as acceptable at 25-75% radiation dose reduction for CT images reconstructed with ASIR**. No significant artifacts were seen affecting diagnostic interpretation. Visibility of small thoracic structures and image contrast on ASIR images were rated as acceptable for all dose levels. There was good interobserver agreement between the two radiologists (k=0.8, $p<0.05$).

CONCLUSION
Acceptable image quality (noise, visibility of small structures) can be obtained for chest CT acquired at 50 mAs using ASIR technique without any substantial artifacts affecting diagnostic acceptability.

CLINICAL RELEVANCE/APPLICATION:
CT exam protocols as low as 50 mAs are possible for chest CT images reconstructed with adaptive statistical iterative reconstruction.

Radiation Dose Reduction with Chest CT Using Adaptive Statistical Iterative Reconstruction Technique: Initial Experience

Priyanka Prakash, MBBS – Abstract Co-Author, Mannudeep Kalra, MD, Jiang Hsieh, PhD, Homer Pien, PhD, Matthew Gilman, MD, Jo-Anne Shepard, MD (MGH, GE)

PURPOSE: To assess radiation dose reduction and image quality for weight based chest CT examinations reconstructed with adaptive statistical iterative reconstruction (ASIR) technique.

METHOD AND MATERIALS:
With local ethical committee approval, weight adjusted chest CT examinations were performed in 98 patients with ASIR and in 54 weight-matched patients with filtered back projection (FBP) on a 64-slice MDCT. Patients were categorized into three groups of <60 kg (n=32), 61-90 kg (n= 77), and >91 kg (n= 43) for weight based adjustment of automatic exposure control technique. Remaining scan parameters were held constant at 0.984:1 pitch, 120 kVp, 40 mm table feed/rotation, 2.5 mm section thickness. Patients' weight, scanning parameters, effective dose, and mean mAs were recorded. Image noise was measured in the descending thoracic aorta at the level of the carina. Two thoracic radiologists independently reviewed chest CT for subjective image noise images (1=too little, 3=too much), diagnostic acceptability (1=fully acceptable,

4=unacceptable), artifacts (1=none, 4=affecting diagnostic information) and critical reproduction of visually sharp anatomical structures. Data were analyzed using analysis of variance (ANOVA).

RESULTS:
ASIR resulted in overall 28% dose reduction in comparison to FBP. Effective dose values were 6.5±1.7 (28.8% decrease), 7.2±1.6 (27.3% decrease) and 12.7±2.3 (26.8 % decrease) mSv, for <60, 61-90 and >91 kg weight groups with ASIR, compared to 9±2, 10±1.9, and 17±2 mSv with FBP respectively (p<0.0001). Despite dose reduction, there was less noise with ASIR (12.6±2.9) than with FBP (16.6 ± 6.2) (p<0.0001). Also, mean mAs also showed a comparable decrease of 29.2% (ASIR, 248±73; FBP, 343±88 mA), 25.9% (ASIR, 264±66; FBP, 348±87 mA) and 25.7% (ASIR, 481±120; FBP, 641±83 mA) for <60, 61-90 and >91 kg weight groups respectively. The two readers consistently found the lower dose ASIR images to have less or the same noise and artifacts as the FBP (p<0.0001). Also, the diagnostic acceptability and critical reproduction of visually sharp anatomical structures was comparable in the lower dose ASIR and standard dose FBP images.

CONCLUSION
ASIR helps reduce chest CT radiation dose and improve image quality compared to the conventionally used FBP image reconstruction.

Chest CT for Diffuse Lung Disease Using Adaptive Statistical Iterative Reconstruction Technique

Priyanka Prakash, MBBS – Abstract Co-Author, Matthew Gilman, MD, Mannudeep Kalra, MD, Subba Digumarthy, MD, Jo-Anne Shepard, MD, Jeanne Ackman, MD (MGH)

PURPOSE: To compare the chest CT for diffuse lung disease, reconstructed with adaptive statistical iterative reconstruction (ASIR) technique and filtered back projection (FBP) for visibility of subtle normal and abnormal findings.

METHOD AND MATERIALS:
Our IRB approved study included chest CT of 24 patients scanned on a 64-slice MDCT (GE Discovery CT 760 HD) for evaluation of diffuse lung disease. Scan parameters included 0.984:1 pitch, 40 mm table speed, 120 kVp, 0.625 mm thick images at 0.625mm interslice gap, and detail kernel. The images were then reconstructed using filtered back projection (FBP) as well adaptive statistical iterative reconstruction (ASIR) techniques. Two thoracic radiologists blinded to image type independently assessed the FBP and ASIR-HD images for small anatomical details (interlobular septa, pleural and subpleural regions, centrilobular region, small bronchi and bronchioles), abnormal findings (reticulation, tiny nodules, altered attenuation, bronchiectesis) on a 5 point scale (1=excellent image quality, 5=interpretation impossible). Image noise (1=unacceptable, 5=minimum) and artifacts (1=affecting diagnostic information, 4=none) were also graded on each dataset. Data were tabulated for statistical testing.

RESULTS:
ASIR images were found to be superior to the FBP images for both anatomical and pathological findings. Moderate to severe blurring of interlobular septa, centrilobular region, and small bronchi and bronchioles was present in 15/24 (62.5%), 10/24 (41.7%), and 13/24 (54.2%) of FBP images in comparison to 3/24 (12.5%), 1/24 (4.2%) and 2/24 (8.3%) of ASIR images, respectively (p<0.0001).The visualization of pleural and subpleural regions and large bronchi and bronchioles was comparable in the FBP and the ASIR groups (p<0.0001). For pathological structures, ASIR images had excellent visualization of pathological findings, unlike FBP, in which moderate blurring of reticular pattern was present in 2/24 (8.4%) and severe in 1/24 images. Tiny nodules were blurred in 6/24 (25%) of FBP cases as compared to none for ASIR. Both the image sets were rated as less than average noise for all cases. No significant image artifacts were present.

CONCLUSION
ASIR images results in superior resolution of subtle anatomy and lesions in DLD chest CT.

CLINICAL RELEVANCE/APPLICATION
Improved CT imaging and visualization of DLD is possible with the use of iterative reconstruction in high resolution mode.

Effects of Arm Position on Quality of CT Reconstructed with Iterative Reconstruction Technique

Priyanka Prakash, MBBS – Abstract Co-Author, Mannudeep Kalra, MD, Subba Digumarthy, MD, Jiang Hsieh, PhD, Matthew Gilman, MD, Jo-Anne Shepard, MD (MGH, GE)

PURPOSE: To determine the effect of patient's arms on image quality and radiation dose of chest CT reconstructed with adaptive statistical iterative reconstruction (ASIR) and feed back projection (FBP) techniques.

METHOD AND MATERIALS:
Study included chest CT performed on 64-slice MDCT in 86 patients. For 48 ASIR reconstructed chest CT, 24 patients (M=15, F=10, age=65±20 years, weight=73±14 kg) with arms by their side, and 24 patients (M=8, F=16; age=55±16 years, weight=72±13 kg) with arms over their head were scanned at 120 kVp, and noise index of 19. For FBP reconstructed chest CT, 19 patients (M=13, F=6; age=64±19 years; weight=76±19 kg) with arms by the side, while 19 patients (M=14 F=5; age=63±16 years; mean weight=77±18 kg) with arms raised were scanned at 120 kVp and noise index of 16.25. Dose metrics and objective noise were recorded. Two thoracic radiologists independently reviewed all chest CT for subjective image noise (1=no noise, 5=unacceptable), beam hardening artifacts (1=affecting diagnostic information, 4=none) and diagnostic acceptability (1=fully acceptable, 4=unacceptable).

RESULTS:
For patients with arms by their side, objective image noise was 20% higher for FBP (15±2) compared to ASIR (11.5±2.8) (p<0.0001) whereas subjective noise was above average in 84% (16/19) FBP studies compared to 37% (9/24) of ASIR reconstructed images (p<0.0001). With ASIR, there was 18.2% increase in noise with arms by the side (11.5±2.8) versus arms above head (9.3±1.9). For FBP, the objective noise increased by 20% with arms by the side (15±2) as compared to arms above (12±1.5). In patients with arms by the side, 42% of CT had artifacts affecting diagnostic information in ASIR group, against 69% in FBP. Despite lower noise and less artifacts, ASIR-CT (10.4±3.6 mSv) had 28% lower radiation dose than FBP images (13.6±5.2 mSv) for patients with arms by side. ASIR-CT (7.5±1.7) also had 33% lower dose compared to FBP (11.2±3.4) for patients with arms above the head (p<0.0001).

CONCLUSION
Scanning the patients with arms by the side leads to more radiation exposure as compared to arms above the head. ASIR helps improve the diagnostic acceptability of images in patients scanned with arms by the side.

CLINICAL RELEVANCE/APPLICATION
When possible, chest CT should be performed with arms raised above the head to reduce the radiation dose. **For patients who can not raise their arms, ASIR can help improve the image quality.**

RSNA 10

Computer-aided Detection for Pulmonary Nodules Using Different Levels of Adaptive Statistical Iterative Reconstruction: Comparison of the Performance between Standard and Low-Dose CT

Masahiro Yanagawa MD (Presenter), Osamu Honda MD, PhD, Mitsuhiro Koyama MD, Ayano Kikuyama, Hiromitsu Sumikawa MD, Noriyuki Tomiyama MD, PhD

PURPOSE: Adaptive statistical iterative reconstruction (ASIR) technique is useful for reducing CT radiation dose and improving image quality. The aim was to evaluate the effect of adaptive statistical iterative reconstruction on the performance of computer-aided detection (CAD) for pulmonary nodules on garnet-based detector CT images.

METHOD AND MATERIALS:
In this prospective clinical study approved by an IRB, 35 patients (mean age 64.6±14.6 years, M:F 18:17) gave informed consent for acquisition chest CT data at standard-dose (120 kVp, automatically adjusted tube current) and low-dose (120 kVp, 100mA) on 64-MDCT (GE Discovery CT750HD). High Resolution scan mode with 2496 views per rotation was used. Each 0.625-mm thickness image was reconstructed at 3 different levels of ASIR (0%, 50%, and 100%). To determine the reference standard, two thoracic radiologists independently assessed CT images with 0%-ASIR and recorded all candidate lesions initially, and then those were classified as true-positive or false-positive findings by the consensus panel. The output of the CAD (GE Lung VCAR) system was only retrospectively assessed, compared with the results of the reference standard. Data were analyzed using analysis of variance (ANOVA, Bonferroni/Dunn's method).

RESULTS:
The consensus panel found 265 noncalcified nodules (Ground-glass opacity [GGO], 103; Part-solid, 34; and Solid, 128) with a diameter of 30mm or less (mean diameter 4.37±3.16 mm). The sensitivity of overall nodules at 100%-ASIR [standard-dose (SD), 71%; low-dose (LD), 52%] was significantly higher than that at 0%-ASIR (SD, 54%; LD, 36%) (p<.001). The sensitivity of GGO at 100%-ASIR (SD, 49%; LD, 25%) was significantly higher than that at 0%-ASIR (SD, 25%; LD, 13%) (p<.001). The sensitivities of Part-solid and Solid at 100%-ASIR (SD, 85% and 84%; LD, 79% and 67%, respectively) tended to be higher than those at 0%-ASIR (SD, 76% and 70%; LD, 53% and 50%, respectively). The mean number of false-positive findings per examination at 100%-ASIR (SD, 8.5; LD, 6.2) was significantly higher than that at 0%-ASIR (SD, 4.6; LD, 3.5) (p<.001).

CONCLUSION
The sensitivity of CAD at 0%-ASIR on standard-dose CT is almost equal to that at 100%-ASIR on low-dose CT. ASIR can improve the sensitivity of CAD for pulmonary nodules although it increases the number of false-positive findings.

Image Quality and Dose Saving Aspects of Adaptive Statistical Iterative Reconstruction (ASIR) in 64-Row CT Imaging of the Chest

Stefan Wirth MD (Presenter), Linus Michael, Markus Koerner MD, Daniel Maxien MD, Ulrich Linsenmaier MD, Maximilian Reiser MD (LMU, Munich)

PURPOSE: To compare 64-row chest CT at different levels of ASIR to prior examinations, which are solely reconstructed by filtered back-projection (FBP) in regard to image quality and dose saving aspects.

METHOD AND MATERIALS:
11 patients with 64-row chest CT (LightSpeed VCT XT, GE) as reference examination and a follow-up study on a CT with ASIR option (Discovery 750HD, GE) were included. As ASIR reduces image noise, the noise index was increased from 29 to 45 while all other scan parameters were identical. For reference and follow-up studies standard images were reconstructed in 3 planes with different ASIR levels (0, 30, 50, 70, and 100%, slice and volume mode, standard and lung kernel). Image noise was measured objectively as standard deviation of HU with 100m²±10% ROI's in 5 different defined tissues (n=660). 2 experienced radiologists performed consensus reading of each plane with respect to image quality regarding soft tissues (standard

kernel) and lung (lung kernel) in comparison to the reference (scale:-2:clearly inferior,-1:inferior,0:equal,+1:superior,+2:clearly superior; n=240). Wilcoxon's test (unpaired samples) and the Mann-Whitney-U-test (paired samples) were used for statistical testing.

RESULTS:
Increasing ASIR levels showed a linear decrease of image noise (p<0.05). With standard kernel, image noise was equal to the reference at ASIR 70, whereas with lung kernel values of the reference were never reached, even at ASIR 100. In subjective evaluation of soft tissues all ASIR levels in slice mode were inferior to the reference (-0.7 to -0.3, p<0.05). For ASIR levels ≥50 volume mode was superior to slice mode (p<0.01) and was equal to the reference at ASIR 100 (-0.05, p=0.26). In contrast, independently from ASIR levels, subjective lung evaluation revealed no difference between slice and volume mode (p=0.44). ASIR 30 to 70 performed superior to ASIR 0 and 100 (p<0.05) without significant differences compared to the reference (0.00 to 0.23, p=0.18). DLP of the follow-up decreased by 57% to 304 mGy*cm (p<0,05).

CONCLUSION
With 57% dose reduction soft tissue evaluation with ASIR 100 in volume mode was equal to the reference whereas for lung evaluation ASIR 0 to 70 (slice or volume mode) were equal to the reference.

Effect of Adaptive Statistical Iterative Reconstruction on Lung CT Images: A Pilot Study Using Porcine Lungs

Jiro Sato MD (Presenter), Masaaki Akahane MD, Sachiko Inano, Mariko Hashimoto MD, Hiroyuki Akai MD, Izuru Matsuda MD, Kouhei Kamiya, Takana Yamakawa MD, Kosuke Sasaki MS, Akira Kunimatsu MD, Kuni Ohtomo MD

PURPOSE: To assess the effect of adaptive statistical iterative reconstruction (ASIR) on lung CT images, and obtain the basis to ensure the optimal use of ASIR for lung CT.

METHOD AND MATERIALS:
Inflated and fixed porcine lungs placed in an oval polymethylmethacrylate phantoms were scanned with a 64-slice CT system. Using automatic exposure control, 40 mAs were chosen as standard dose. 10 and 20 mAs were used for reduced dose model and 400 mAs for the highest quality image. All scan data were reconstructed with filtered back projection (FBP) and 20% and 40% ASIR; however, ASIR was not used for the data obtained at 400 mAs. Factorial combination of 10 axial images at the same level yielded 100 image pairs. Using a 21-point scale, 3 experienced radiologists independently rated differences in quality between adjacently displayed paired images for image noise, visually sharp reproduction of bronchovascular structures, and conspicuity of tiny nodules. For each evaluation item and each dose and ASIR setting, subjective image quality score (SQS) was computed based on Anderson's functional measurement theory. Standard deviation (SD) within regions of interest placed on homogeneous parts of the lung was recorded as quantitative noise data. SQSs were analyzed by Tukey's honestly significant differences test. Pearson's correlation coefficients between the SDs and SQSs were calculated.

RESULTS:
At any dose, SQSs were improved with ASIR for all evaluation items. No significant differences were noted between the SQSs for 40%-ASIR image obtained at 20 mAs and those for FBP image at 40 mAs. The SQSs for 40%-ASIR image at 10mAs were significantly lower than those for FBP image at 20 mAs. Although the SQSs closely correlated with the SDs of image pixels (r < -0.95 for all evaluation items), the SQSs were lower for reduced-dose ASIR images than for standard-dose FBP images, with a nearly same SD value, especially for nodule.

CONCLUSION: **ASIR for lung CT possibly enables 50% dose reduction with visualization of small structures preserved**. Although ASIR appears to improve image quality at any dose, especially with regard to noise, degradation of spatial resolution owing to dose reduction may hamper the use of very low-dose ASIR images.

CLINICAL RELEVANCE/APPLICATION
Compared to the standard FBP algorithm, adaptive statistical iterative reconstruction for lung CT enables 50% dose reduction with visualization of small structures preserved.

Ultra-Low-Dose CT of the Lung with Radiography-comparable Dose: Efficacy for Lung Nodule Detection with Use of Adaptive Statistical Iterative Reconstruction (ASIR)

Hyun Jung Yoon MD (Presenter), Myung Jin Chung MD, Hyo Jin Kim, Jungjae Park MD, Ho Yun Lee MD, Kyung Lee MD, PhD

PURPOSE: Recently, low dose CT has been used as a screening tool for lung cancer. However patient dose of LDCT ($\simeq$1 mSv) is not yet low enough to relive entirely from the radiation risk. ASIR allows one to reduce tube current as compared with filtered back projection (FBP) algorithms. The purpose of this study was to assess accuracy of ultra low dose CT (ULDCT) using ASIR blending for small lung nodule detection.

METHOD AND MATERIALS:
Our institutional review board approved this prospective study, and written informed consent was obtained from all study participants. Thirty-five patients underwent ULDCT and standard dose CT (SCT) simultaneously. **ULDCT scans were obtained with 120kVp, 10mA fixed tube current, 0.5-sec gantry rotation**, and 0.97 beam pitch. Mean dose-length product was 12 ± 1 mGy-cm. **Converted effective doses were 0.20 ± .01 mSv**. ASIR- and FBP-driven axial CT images were reconstructed with 36 - 38 cm FOV, 2.5 mm thickness, and high spatial frequency algorithm. Applied ASIR blending ratio was 60%. A total of 187 lung nodules (< 2 cm) were found at SCT. Their size, shape, and location on SCT were recorded. Two radiologists blinded from SCT results reviewed both subsets of ASIR- and FBP-driven images independently. Data assessed by each radiologist were compared.

RESULTS:
On FBP-driven image, observers detected 119 and 105 true nodules (sensitivity, 64% and 56% for observer 1 and 2, respectively), and 61 and 35 false nodules (false positive predictability (FPP), 35% and 25%, respectively). On ASIR-driven images, observers detected 139 and 131 true nodules (sensitivity, 74% and 70%), and 92 and 37 false nodules (FPP, 40% and 22%). For the significant-sized (≥ 3 mm) non-calcified nodules (SN), sensitivities were superior on ASIR- (80% and 75%) than FBP-driven (62% and 58%) images (P < .01, McNemar test). ASIR-driven ULDCT helped detect 84% (sensitivity, 84% and 84%) of peripherally-located SNs and 69% (sensitivity, 71% and 67%) of ground glass opacity nodules. Inter-observer agreements were poor (K = .27, Kappa test) on FBP-, but moderate (K = .52) on ASIR-driven images.

CONCLUSION: **ASIR-driven ULDCT with only 0.2 mSv of radiation dose allows one to detect successfully small lung nodules.**

CLINICAL RELEVANCE/APPLICATION: **Radiation dose of ASIR-driven ULDCT (about 0.2 mSv) is comparable to that of plain chest radiography (about 0.1 mSv). The technique can be used in lung cancer screening with the least radiation risk.**

ECR 2010

Clinical study of the low-dose chest screening with high definition CT (HD750)

J. Chen Beijing/CN

PURPOSE: To evaluate the dose reduction potential of chest screening with energy spectrum high definition CT (HDCT).

METHOD AND MATERIALS:
200 health examination people underwent chest screening scans using HDCT with automatic tube current (mA) modulation on energy spectrum CT. They were categorized randomly into four groups, , randomly. The noise index (NI) for the study group 1, the study group 2 ,3 and the control group were set to 22HU, 30HU, 40HU and 15HU, respectively. The adaptive statistical iterative reconstruction (ASiR) for each group was set to 50%, 50%, 50% and 30%, respectively. CT dose index volumes (CTDIvol) and dose length product (DLP) were recorded, while effective dose (ED) was estimated. Image quality was assessed by two radiologists on a 5-points scale. The degree of interobservers concordance was evaluated using with calculation of Kappa statistics.

RESULTS:
The average CTDIvol for study group 1, study group 2,3 and control group was (3.00±1.413.31±1.39) mGy, (1.48±0.531.52±0.49) mGy, (0.77±0.46) mGy and (5.51±2.21) 5.51mGy, (Please fix these numbers) respectively. Compared to the control group, the average CTDIvol decrease in the study group 1, 2 and 3 were 45.60%, 73.12% and 86.0%, while DLP and ED decrease in these three study groups were 48.64%, 73.7% and 86.7%. The ED in study group 3 decreased to (0.36±0.210.74±0.27) mSv. The images of each group had acceptable image quality, and there was inter-observer agreement in diagnosis acceptability.

CONCLUSION
HDCT can be used to obtain consistent image quality with remarkable radiation dose reduction.

Low dose thorax imaging with an adaptive statistical iterative reconstruction (ASIR) on HDCT

G. Lo1, J. Chan1, C. Lau1, S. K. Yu1, Y. Shen2, Y. Guo2; 1Hong Kong/CN, 2Beijing/CN

PURPOSE: High definition computed tomography (HDCT) is capable to provide high quality and low radiation dose imaging with new gemstone detector and new reconstruction (ASIR). The purpose of this study was to evaluate the effect of ASIR on radiation dose and image quality in CT thorax imaging using HDCT.

METHOD AND MATERIALS:
Twenty-three patients underwent thorax scan on HDCT scanner with auto-adjusted mA (Noise Index adjusted by Body Mass Index: 22~28) were included in this study. Axial images were reconstructed with and without ASIR. The radiation dose was recorded and the image quality was evaluated in a double-blind manner by two radiologists using a 5-point scoring system (excellent: 1;bad: 5). The noise level (standard deviation of CT values) in different tissue was also measured. Statistical t test analysis on image quality score and noise of the axial images were performed.

RESULTS:
The average radiation dose was 4.43+/-2.56 mSv. The average image quality score in mediastinum (at Ascending Aorta level) in ASIR group (1.09+/-0.29) was statistical significantly (p < 0.05) better than the non-ASIR group (2.00+/-0.30). There was no statistically difference in the image quality score of lung tissue (at Bifurcation、Left ventricle level) between the two groups. The average noise level of different tissue was

statistical significantly lower in ASIR group (Ascending Aorta: Av =12.11; Muscle: Av =19.32; Bone: Av = 42.16) than in the non-ASIR group (Ascending Aorta: Av =14.72; Muscle: Av =21.96; Bone: Av = 44.30). The percentage decrease of image noise in the axial view was 18% in ascending aorta, 12% in muscle and 7% in bone. It was also found that the noise reduction is more effective for thinner slice thickness.

CONCLUSION
The HDCT can provide more diagnosis information and more consistent image quality with ASIR algorithm. Since the image noise can be effectively reduced by ASIR, it allows a significant reduction of radiation dose in CT thorax imaging.

ECR 2011

Dose saving potential of adaptive statistical iterative reconstruction (ASIR) in 64-row CT imaging of the chest

S. Wirth, L. Michael, M. Scherr, M. Körner, U. Linsenmaier, E. Ziegeler, F. Mück, D. Maxien, M. F. Reiser; Munich/DE

PURPOSE: To compare 64-row chest CT at different levels of ASIR to prior examinations, which are solely reconstructed by filtered back-projection (FBP) in regard to image quality and dose saving potential.

METHOD AND MATERIALS:
23 patients with 64-row chest CT (LightSpeed VCT XT, GE) as reference and a follow-up study on a CT with ASIR option (Discovery 750HD, GE) were included. For follow-up's the noise index was increased from 29 to 43 while all other scan parameters were held constant. Images were reconstructed in 3 planes with different ASIR levels (0,30,50,70, and 100 %, slice and volume mode, standard and lung kernel). 2 experienced radiologists performed consensus reading with respect to image quality regarding soft tissues (standard kernel) and lung (lung kernel) in comparison to the reference (-2:clearly inferior, -1:inferior, 0:equal, +1:superior, +2:clearly superior). The Mann-Whitney-U-test was used for statistical testing

RESULTS:
For soft tissue evaluation all ASIR levels in slice mode were inferior to the reference (-0.9 to -0.4, $p<0.05$). For ASIR levels of 50 and higher, volume mode was superior to slice mode ($p<0.01$) and was equal to the reference at ASIR 70 exclusively for axial images (-0.00, $p>0.05$). For evaluation of the lung ASIR 0 to 70 performed at least equal compared to the reference (0.00 to 0.35, $p>0.05$). DLP of the follow-up's decreased by 53 % to 320 mGy*cm ($p<0,05$)

CONCLUSION
Soft tissue evaluation with ASIR 70 in volume mode allows for dose savings of about 50 %. For evaluation of the lung standard FBP images remain sufficient.

Low dose computer tomography (LDCT) imaging of the paediatric chest: a phantom study on the use of iterative reconstruction (IR) as a new advanced reconstruction technique

C.-P. Wallner, M. Körner, U. Linsenmaier, K. Schneider, M.F. Reiser; Munich/DE

PURPOSE: To evaluate the use of iterative reconstruction technique for dose reduction and image quality improvement in computer tomography (CT) of the paediatric chest.

METHOD AND MATERIALS:

Background Low-dose pediatric chest CT scans using the adaptive statistical iterative reconstruction (ASIR) method and the standard pediatric LDCT protocol were performed on a GE Discovery CT 750HD. Natural sponges as lung equivalent saturated with iodinated contrast media inserted within a chicken specimen simulating a neonatal patient and within a turkey specimen as an infant phantom were used. For the neonatal studies tube current was 80 kVp, for the infant studies 100 kVp. The ASIR reconstruction level was 40 % for both the neonatal and the infant examinations. The noise index was identical for all protocols with a value of 45.
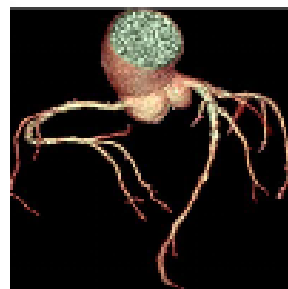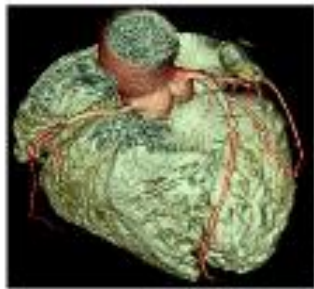

RESULTS:

The radiation dose delivered during the LDCT scan without IR was 1.64 mGy CTDI (25.25 mGy*cm DLP) for the neonatal phantom and 4.06 mGy CTDI (100.79 mGy*cm DLP) for the infant phantom. For the neonatal phantom the dose delivered using LDCT with IR was 0.93 mGy CTDI (14.30 mGy*cm DLP) and for the infant phantom 2.29 mGy CTDI (57.92 mGy*cm DLP). Dose reduction was 43.3% for the 80 kVp neonatal protocol and 43.6% for the 100 kVp infant protocol.

CONCLUSION

With iterative reconstruction technique compared to a standard LDCT pediatric chest protocol we found the patient radiation dose being significantly reduced up to 44 % when using the low-dose IR method. The resulting diagnostic image quality was similar for both methods.

CARDIAC IMAGING

RSNA 09

A Multicenter Evaluation of Estimated Radiation Dose of Coronary CT Angiography Using Adaptive Statistical Iterative Reconstruction (ERASIR I)

James Earls, MD – Abstract Co-Author, Troy Labounty, James Min, Fay Lin, Brett Heilbron, MD, FRCPC, Jonathan Leipsic, MD (Fairfax Associates Cornell, St. Pauls, Vancouver)

PURPOSE: CT image reconstruction using adaptive statistical iterative reconstruction (ASIR), in contrast to filtered backprojection, utilizes statistical modeling to reduce image noise. This allows for reduced tube current and radiation dose in coronary CT angiography (CCTA) studies. Combining ASIR with other dose reduction techniques may result in reduced radiation with preserved diagnostic quality.

METHOD AND MATERIALS:
We evaluated radiation doses in **1150 consecutive patients** at three centers referred for CCTA in three arms: 64-detector CCTA with filtered backprojection (FBP, n=735), 64-detector **high-definition CCTA with ASIR** (ASIR pre-protocol, n=247), and the latter **following initiation of a dose-reduction protocol** (ASIR post-protocol, n=168). The protocol recommended 100kV imaging, reduced current based on BMI, and minimal use of padding. Patient and scan parameters, signal to noise ratios, diagnostic quality, and radiation doses were compared.

RESULTS:
The mean age, BMI, and heart rate did not differ significantly between the 3 groups. 100 kV was used in 2% of FBP, 13% of ASIR pre-protocol, and 63% of ASIR post-protocol. Prospective gating was used in 90% of FBP, 88% ASIR pre-protocol, and 92% ASIR post-protocol. The mean effective radiation dose was 3.8 mSv for all FBP studies, 2.6 mSv ASIR pre-protocol, and **1.3 mSv post-protocol**. The percentage of interpretable coronary segments was 99% for each of the 3 groups. Independent of patient parameters, ASIR was associated with reduced current use (-169 mA, p<0.001). In prospectively gated studies, reduced radiation exposure was independently associated with decreased current (-0.60 mSv per -100 mA, p<0.001), less padding (-1.6 mSv per -100 msec, p<0.001), 100kV vs. 120 kV tube voltage (-1.0 mSv, p<0.001), and shorter scan length (-0.13 mSv per 1 cm , p<0.001).

CONCLUSION
Use of ASIR resulted in reduced current and radiation doses in a multicenter consecutive cohort. The implementation of a common ASIR protocol permitted CCTA exams with a median of 1.3 mSv of radiation. Despite the reduced radiation dose, image interpretability and signal to noise ratio of post-protocol ASIR and filtered backprojection were similar.

CLINICAL RELEVANCE/APPLICATION
Radiation dose has been a concern with use of cardiac CT, use of ASIR and additional dose reduction techniques allows for a **very low mean dose**, applicable across all patients.

Assessment of Coronary Stents Using High Definition CT with Adaptive Statistical Iterative Reconstruction: A Phantom Study

Siu Ki Yu PhD, PhD – Abstract Co-Author, Gladys Lo, MD, Yun Shen, PhD, C.Y. Poon, Y.W. Ho, Eiko Ueno, MD (Hong Kong Sanatorium Hospital and CTRC)

PURPOSE: High Definition CT (HDCT) with Adaptive Statistical Iterative reconstruction (ASIR) is capable of reducing image noise and improving spatial resolution. It is the aim of this study to investigate the effect of ASIR in the coronary stents assessment.

METHOD AND MATERIALS:
Seven coronary artery stent phantoms (MultiLink-3.0mm; PENTA-3.0mm; TSUNAMI-3.0mm; Cypher-2.5mm; Cypher-3.0mm; Cypher-3.5mm; S670-3.0mm) filled with contrast fluid and surrounded by water were scanned using HDCT. The phantoms were positioned at the bore center of the CT scanner. Images were

acquired using 80kVp 560mA, 100kVp 360mA and 120kVp 250mA in helical mode. Each scan was reconstructed using both ASIR and conventional filtered backprojection (FBP) methods with the same reconstruction filter. To assess the effect on in-stent lumen size, measurements were made at ten different stent locations for each stent. The measured average value was compared with the actual physical dimension. To assess the effect on the in-stent visibility, reconstructed images were evaluated by 4 physicists using a 5-point scoring scheme (1 = not visible; 5 = excellent visibility). Inter-observers agreement was evaluated by kappa statistics.

RESULTS:
The measured in-stent lumen sizes were all underestimated. **The average accuracy was improved** from 29+/-6% (FBP) to 34+/-6% (ASIR) at 80kVp, 30+/-4% (FBP) to 32+/-6% (ASIR) at 100kVp, and 31+/-6% (FBP) to 36+/-7% (ASIR) at 120kVp. The in-stent lumen visibility was found comparable using ASIR (mean score = 3.3+/-0.8 at 80kVp; 3.3+/-0.8 at 100kVp, 3.3+/-0.9 at 120kVp) and FBP (mean score = 3.0+/-0.7 at 80kVp; 3.1+/-0.9 at 100kVp, 3.7+/-0.8 at 120kVp). The inter-observers agreements were moderate (k=0.25 at 80kVp, k=0.33 at 100kVp, k=0.48 at 120kVp) in ASIR and (k=0.25 at 80kVp, k=0.33 at 100kVp, k=0.48 at 120kVp) in FBP.

CONCLUSION
The new adaptive statistical iterative reconstruction algorithm can improve the accuracy and give comparable visibility of the coronary stents assessment.

CLINICAL RELEVANCE/APPLICATION
Assessment of coronary stents using HDCT with ASIR.

RSNA 10

Evaluation of the Diagnostic Image Quality of Pediatric Cardiac CT Examinations When Reconstructed with an Adaptive Statistical Iterative Reconstruction

Frédéric Mieville MD (Presenter), Paul Ayestaran PhD, Elena Rizzo MD, François Gudinchet MD, Phalla Ou MD, Francis Brunelle MD, PhD, François Bochu PhD, Francis Verdun PhD

PURPOSE:
To quantify the benefits provided on the diagnostic image quality of pediatric cardiac CT examinations by the ASIR method with respect to the FBP

METHOD AND MATERIALS:
Four pediatric radiologists based in two different clinical centers (France and Switzerland) evaluated ten low-dose pediatric cardiac examinations. The study cohort was composed of 6 males and 4 females with an average age of 2.5 years and an average weight of 10 kg. Acquisitions were performed on a 64-MDCT scanner with a peak voltage of 80 kVp. The same protocol was applied on a pediatric phantom when varying the CT dose index (CTDIvol). All images were reconstructed with different percentages of ASIR (0% up to 100%). For each exam, radiologists had to score a set of 19 anatomical structures using the visual grading analysis (VGA) method. Phantom metrics, such as the noise power spectrum (NPS) were computed as well.

RESULTS:
Due to ethical reasons, the diagnostic quality of a reconstructed exam was evaluated at fixed CTDIvol. A significant difference of the structure visibility (p<.001) was observed between reconstructions. The four radiologists considered that the best structure visibility for pediatric cardiac exams was obtained with around ASIR 30% whereas above ASIR 50% the image quality became significantly lower than the reference image. ASIR 30% was the best reconstruction for all the structure scored, except for pulmonary interstice where ASIR 50% was well adapted. The NPS shape curve was modified and its amplitude reduced when ASIR percentage increased up to ASIR 100%. However, low contrast visibility was not strongly improved. **The potential dose reduction was estimated with a pediatric phantom when applying the pediatric cardiac protocol at the cohort average dose (6 mGy). For a fixed value of noise (σ = 15.5 HU), CTDIvol can be reduced by 32% and 48% with ASIR 30% and ASIR 50%, respectively.**

CONCLUSION
The results of the present study indicate that ASIR methods improve the image quality on clinical exams and on phantoms. However, in a clinical environment, ASIR 30% should be used because it produces the best trade-off between noise reduction and image aspect.

CLINICAL RELEVANCE/APPLICATION
Adaptive Statistical Iterative Reconstruction (ASIR) is a new imaging reconstruction technique recently introduced by General Electric (GE) in their last generation-computed tomography (CT) scanner.

ECR 2011

In vivo reduction of radiation exposure with a single-source coronary CT angiography: effects of optimal parameters settings in real life conditions

A. Tavildari, L. Maillard, F. Vochelet; Aix en Provence/FR

PURPOSE: To assess the feasibility of in vivo radiation reduction by modifying acquisition parameters in real life conditions during a coronary computed tomographic angiography (CCTA) with a classic single source 64-slice computed tomography. CCTA has become a key diagnostic exam for coronary artery disease (CAD); however, radiation exposure has been deemed too high

METHODS AND MATERIALS:
During a pre-study period, which enrolled 519 patients, two steps of improvement have been tested. 1) Acquisition at 80 or 100 kV instead of 120 kV and a majority of prospective acquisition (n=56), 2) Avoiding every useless X-ray radiation and no EKG-padding (n=463). These steps allowed us to determine the best settings. During the study period, acquisition of 137 consecutive patients for examination of native coronary arteries with suspected CAD was performed with these parameters. Prospective mode was performed for patients with a heart rate (HR) under 65 bpm; retrospective acquisition was used otherwise.

RESULTS:
For the pre-study period, the mean dose length product (DLP) decreased at each step. For the study period, a mean DLP of 56±22.2 mGy×cm (0.7±0.3 mSv) was obtained with prospective acquisition (n=117) i.e. significantly lower than retrospective acquisition: 575 ± 130.8 mGy×cm (7.4 ± 1.8 mSv) (n=20), $p<0.0001$ and significantly lower than conventional coronary angiography (8.54 ± 2.16 mSv) (n=13), $p<0.0001$.

CONCLUSION
Coronary CT using very low Xray exposure is feasible and accurate. Prospective acquisition with optimal parameters settings delivers the lowest radiation; up to ten times lower than conventional coronary angiography

Advanced Non-invasive Imaging in Assessment of Kawasaki's Disease: Low-Dose Computed Tomography and Magnetic Resonance Imaging

S. Madan, M. D. V. Mishra, G. Sreedher, F. A. Escobar, V. Allada, S. Tadros; Pittsburgh, PA/US

LEARNING OBJECTIVES: 1. Discuss advanced imaging techniques with low dose Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) including three-dimensional (3D) MR free breathing coronary artery imaging in assessment of Kawasaki's Disease (KD) in children and young adults. 2. Address decreased radiation dose in non-invasive coronary angiography with prospective gating and Adaptive Statistical Iterative Reconstruction (ASIR). 3. Illustrate imaging findings of pre and post treatment evaluation of KD.

BACKGROUND:
KD is an acute self-limiting vasculitis of unknown etiology, which affects about 4000 children in the United States annually. It is the leading cause of acquired heart disease in children. In untreated patients, the incidence of coronary artery aneurysms is about 20 to 25 percent with a mortality rate of approximately 2

percent. Initial and follow-up assessment of cardiovascular function, morphology and myocardial viability assessment is hence critical for improved management and prognosis.
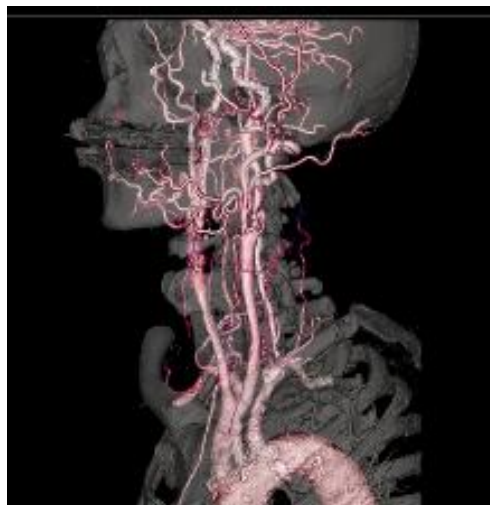
IMAGE FINDINGS OR PROCEDURE DETAILS:

Echocardiography provides information on proximal course of the coronaries and qualitative functional assessment. However' it is limited by poor acoustic windows, operator dependance, and patient body habitus. Multi-detector CT with prospective gating and ASIR application allows assessment of coronary arteries with low dose (<3mSv) and high spatial resolution. MRI with MR Angiogram is non-invasive, non-radiating procedure and allows morphological, functional, flow and myocardial viability assessment. Advanced MRI techniques include 3D MR free-breathing coronary artery imaging which allows for volumetric acquisition of the coronary arteries without contrast use.

CONCLUSION

Advanced low-dose CT and MRI techniques are essential for pre- and post- therapy cardiovascular morphology, function and myocardial viability assessment of patients with KD for improved management and prognosis

NEURO & NECK IMAGING

RSNA 09

Reducing Effective Dose from CT Perfusion with Adaptive Statistical Iterative Reconstruction (ASIR)

Ting-Yim Lee, MSc, PhD – Abstract Co-Author, Aaron So, Glenn Bauman, MD, Jiang Hsieh, PhD, Jean-Baptiste Thibault, Roman Kozak, MD (London Health, GE)

PURPOSE: Radiation dose is a critical limitation in the use of CT Perfusion (CTP) to measure cerebral blood flow (CBF) and blood volume (CBV) in stroke and brain tumor patients. We investigated the use of ASIR (GE Healthcare) to reduce radiation dose from CTP studies.

METHOD AND MATERIALS:
Four brain tumor patients were studied. Each patient had two CTP brain studies separated by 10 min on a HD 750 CT scanner (GE) with injection of 1ml•kg-1 Omnipaque 300 at a rate of 3 ml•s-1 each time. Both studies used a two phase protocol scanning eight 5 mm thick slices at 80 kVp: 1s images at 0.5 s intervals for 45 s followed by images at 15 s intervals for another 90 s. The x-ray tube current was reduced from 200mA (HD) to 20 mA (LD) between studies. Images in both studies were reconstructed with regular filter backprojection and with ASIR(GE) and CBF, CBV and average maps were generated from them using CT Perfusion 4 software(GE). Grey and white matter were segmented using HU thresholds from the average maps and their pixel masks superimposed on the CBF and CBF maps to determine the mean (M) and standard deviation (σ) of each parameter in the respective tissue. A figure of merit (FOM), defined as σ/M of the parameter in the tissue, was used to asses the quality of each grey or white matter parametric map: smaller FOM implies better quality and vice versa. Paired t-tests were used to compare FOMs from HD and LD studies reconstructed with and without ASIR.

RESULTS:
For white matter CBF, the FOMs for HD, HD+ASIR, LD and LD+ASIR were 0.44±0.03, 0.43±0.05 (NS), 0.63±0.09 (*) and 0.49±0.04 (NS), where NS denotes non-significant and * significant differences from HD; and those for white matter CBV were: 0.37±0.03, 0.36±0.03 (NS), 0.61±0.01(*) and 0.47±0.05 (NS). Similar results were obtained for grey matter CBF and CBV.

CONCLUSION
This study showed that ASIR can reduce the effective dose of a CT Perfusion brain study by 10 times (5.9 vs 0.59 mSv) relative to the standard technique of 80kVp and 200mAs per image without affecting the quality of CBF and CBV maps in both grey and white matter. The recommended standard technique for CT Perfusion may not be dose limited because ASIR did not improve the quality of parametric maps obtained.

CLINICAL RELEVANCE/APPLICATION
The low effective dose made possible with the application of ASIR will increase the use of CT Perfusion brain studies in stroke and brain tumor patients.

Adaptive Statistical Iterative Reconstruction (ASIR) Markedly Improves Signal and Contrast-to-Noise Ratios in Low Dose Head CT Scanning

Shervin Kamalian, MD – Abstract Co-Author, Otto Rapalino, MD, M. Kamalian, MD, Seyedmehdi Payabvash, MD, Michael Lev, MD, Stuart Pomerantz, MD (MGH)

PURPOSE: Radiation dose reduction in CT is limited by scan degradation from increased image noise. Adaptive Statistical Iterative Reconstruction (ASIR) is a time-efficient clinically available CT reconstruction technique for reducing image noise in the creation of source CT images at the scanner. We evaluated its effect on quantitative measures of brain image quality at multiple ASIR levels.

METHOD AND MATERIALS:
40 consecutive non-contrast head CTs acquired on GEHC Discovery CT750HD, using our clinically routine reduced-dose protocol (120 kV, 200 mA) were included in this study. For each scan, images without ASIR reconstruction were analyzed and compared to images reconstructed at 5 different levels of ASIR (20%, 40%, 60%, 80% and 100%). Region-of-interest (ROI) measurements of CT attenuation (HU) were acquired over normal gray matter (GM) and white matter (WM). Ten scans had a hypodense subacute infarct infarction over which additional ROIs were obtained (INF) and compared to contralateral normal tissue (NL). Signal-to-noise ratio (SNR), defined as mean attenuation over standard deviation, was calculated for each tissue region at each different ASIR level. Contrast-to-noise ratios (CNR) for GM-WM and INF-NL were calculated as the difference in mean attenuation for the two regions divided by the square root of the sum of their squared standard deviations. One-way variance analysis (Tukey's post hoc test) was used to determine statistical significance ($p < 0.05$).

RESULTS:
For GM, WM, INF and NL regions, SNR increased from 8.64, 6.81, 4.41, and 7.56, respectively, without ASIR, to 14.98, 11.58, 7.26, and 10.94 at 100% ASIR (p <.05). GM-WM and INF-NL CNRs increased from 1.34 and 2.49 without ASIR, to 2.93 and 4.54 at 100% ASIR (p<.05). SNR and CNR improvements from ASIR can be attributed primarily to reduction in image noise, as progressive ASIR levels were not observed to raise HU attenuation.

CONCLUSION
Adaptive Statistical Iterative Reconstruction is a tool that may enable significant radiation dose reduction of head CTs with preserved image quality by substantially reducing image noise.

RSNA 10

Optimal Use of Adaptive Statistical Iterative Reconstruction and Reduction of Tube Current to Reduce Radiation Dose to the Eye Lens on Sinus Multi-Detector CT: Study in a Phantom

Haruhiko Machida MD (Presenter), Isao Tanaka, Rika Fukui, Cheng Zhou MD, Toshiyuki Yuhara, Eiko Ueno MD

PURPOSE: Adaptive statistical iterative reconstruction (ASiR) is expected to reduce radiation dose to the eye lens without degrading image quality on sinus multi-detector CT (MDCT), though maximal image quality is not critical for most sinonasal diseases because of inherent high contrast in this region. In a phantom, we determined the optimal tube current and ratio of ASiR to filtered back projection (FBP) to minimize radiation dose to the eye lens and maintain similar image noise on sinus MDCT.

METHOD AND MATERIALS:
Using tube currents of 25, 50, 100, and 200 mA, we scanned a quality assurance (QA) phantom using 120-kV tube voltage, 0.6-second rotation speed, and 1.375 helical pitch and a Rando® phantom (The Phantom Laboratory, Salem, NY, USA) with glass dosimeters on both eyelids with 120-kV tube voltage, 0.5-second rotation speed, and 0.984 helical pitch by 64-detector CT. We reconstructed the QA phantom images with ratios of ASiR to FBP from 0% to 100% (10% interval), measured the standard deviation (SD) of CT value within 5 regions of interest in each of 3 images, and calculated the average SD under each condition. We measured the average eye dose at each tube current and determined the optimal tube current and ratio of ASiR to FBP to minimize radiation dose to the eye and achieve similar image noise to that of our current routine protocol (200 mA and ASiR 0%).

RESULTS:
The average SD for the QA phantom image decreased as the ratio of ASiR to FBP and tube current increased: 7.5 ± 0.6 with 200 mA and ASiR 0%, 7.5 ± 0.6 with 100 mA and ASiR 50%, and 7.6 ± 0.6 with 100 mA and ASiR 80%. That value was 7.9 ± 0.7 and higher for 25 mA at every ratio of ASiR to FBP. The eye dose decreased proportionally to decreasing tube current: 43451.3 ± 3022.1 µGy with 200 mA; 21578.3 ± 578.3

µGy, 100 mA; and 10570.7 ± 295.0 µGy, 50 mA. Thus, eye dose was reduced about 75% with 50 mA and ASiR 80% compared to 200 mA and ASiR 0%.

CONCLUSION
Compared to our current routine protocol, using 50 mA and ASiR 80% reduced eye lens radiation dose approximately 75% with similar image noise on sinus MDCT.

CLINICAL RELEVANCE/APPLICATION
ASiR and reduced tube current are used optimally clinically to reduce radiation dose to the eye lens and maintain image noise level.

Reduced Dose Dynamic CT Using Adaptive Statistical Iterative Reconstruction (ASIR) Allows for Precise Preoperative Localization of Parathyroid Adenomas

Puneet Pawha MD (Presenter), Jose Rios MD, PhD, Lawrence Tanenbaum MD, Peter Som MD, Amit Aggarwal MD (Mount Sinai, NY)

PURPOSE: In recent years, dynamic MDCT has been described as an alternative method for parathyroid adenoma localization. Although CT provides superior anatomic detail to sestamibi scanning and ultrasound for surgical planning, dose considerations have prevented more widespread use. We evaluate the sensitivity of reduced dose dynamic CT (using ASIR reconstruction algorithm) for preoperative localization of parathyroid adenomas.

METHOD AND MATERIALS:
20 patients referred for CT evaluation of primary hyperparathyroidism were scanned using a tailored dynamic CT protocol using a GE Lightspeed VCT scanner. A reduced dose protocol was employed using adaptive statistical iterative reconstruction (ASIR). Data was post-processed using CT perfusion 4 software on a GE AW workstation. Enhancement curves and color maps were generated and analyzed during interpretation, in addition to conventional cross sectional images. Scans were prospectively interpreted by a single neuroradiologist experienced in parathyroid imaging. 10/20 patients underwent parathyroidectomy surgery. CT reports, operative findings and pathology reports were reviewed for all 10 patients.

RESULTS:
Precise preoperative localization by reduced dose dynamic CT was surgically confirmed in 10/10 patients. Appropriate decrease in intraoperative kinetic serum calcium levels was demonstrated in all patients with removal of the prospectively reported lesion. There were no false positive or false negative cases.

CONCLUSION
Dynamic MDCT performed using reduced dose techniques (including ASIR reconstruction algorithm) is an effective and practical tool for precise preoperative localization of parathyroid adenomas in patients with primary hyperparathyroidism.

CLINICAL RELEVANCE/APPLICATION
Reduced dose dynamic CT is helpful in the preoperative evaluation of patients with primary hyperparathyroidism, particularly in light of the increasing use of minimally invasive targeted surgery.

Impact of Different Levels of Adaptive Statistical Iterative Reconstruction on Image Quality in Pediatric Head CT Exams

Anne Thilander-Klang PhD (Presenter), Fredrik Stålhammar MD, Lars-Martin Wiklund MD, PhD, Liz Ivarsson MD, Kerstin Ledenius MS, Simone Eriksson MMEDSC (Queen Silvia Hospital, Göthenburg, Sweden)

PURPOSE: To evaluate the impact of Adaptive Statistical iterative Reconstruction (ASiR) on image quality in pediatric head CT exams.

METHOD AND MATERIALS:
Prior to the study 30% of ASiR (and 70% of filtered back projection (FBP)) was clinically used, based on experience from adult head CT exams. Original digital scanning data from 19 patients (mean age 11 years; range 5 to 17 years) undergoing routine head CT on a 64 slice MDCT scanner (GE Discovery CT750 HD) were retrospectively reconstructed using 0, 20, 30, 40, 50, 60 and 100% of ASiR. Three experienced pediatric radiologists assessed the 5 mm thick axial images in stacks in a blinded randomized visualization study. The reproduction of six anatomical structures in the brain and the overall diagnostic acceptability were assessed using a four point verbal rating scale. Data were analyzed using a method for paired ordinal data that identifies and measures systematic disagreement separately from individual variations in paired assessments. Noise, determined as the standard deviation of the CT-value in Hounsfield Units (HU), was measured for each image stack.

RESULTS:
Frequency distribution of all the assessments for all observers showed that 50% of ASiR generated the highest-ranking scores. Comparison of the overall diagnostic acceptability between 30% and 50% of ASiR resulted in a Relative Position (RP) value of -0.21 (95% CI -0.34 to -0.07), which means that it was rated significantly higher for 50% of ASiR. The visibility of the basal ganglia improved with increased ASiR-percentage while the delineation of the cerebrospinal fluid around the brain decreased when ASiR of 60% or more was used.Intraobserver agreement regarding all evaluation criteria was 45%, 81% and 85% for observer 1, 2 and 3, respectively. Interobserver agreement regarding the overall diagnostic acceptability for observer 1 vs. 2 was 54%, 1 vs. 3 was 56 % and 2 vs. 3 was 65%.The image noise level for 50% of ASiR was 2.7 ± 0.2 HU compared to the level of 30% of ASiR, which was 3.1 ± 0.3 HU.

CONCLUSION
Using 50% of ASiR improves image quality of pediatric head CT exams at the same dose level used at 30% of ASiR (original images). This indicates that further dose reduction is possible.

CLINICAL RELEVANCE/APPLICATION
Using the optimal combination of ASiR and filtered back projection (FBP) will possibly increase the diagnostic quality in pediatric head CT exams and enable dose reduction at preserved image quality.

Adaptive Statistical Iterative Reconstruction (ASIR) Markedly Improves Signal- And Contrast-to-Noise Ratios in Low Dose Head CT Scanning

Shervin Kamalian, MD – Abstract Co-Author, Otto Rapalino, MD, M. Kamalian, MD, Seyedmehdi Payabvash, MD, Michael Lev, MD, Stuart Pomerantz, MD (MGH)

PURPOSE: Radiation dose reduction in CT is limited by scan degradation from increased image noise. Adaptive Statistical Iterative Reconstruction (ASIR) is a time-efficient clinically available CT reconstruction technique for reducing image noise in the creation of source CT images at the scanner. We evaluated its effect on quantitative measures of brain image quality at multiple ASIR levels.

METHOD AND MATERIALS:
40 consecutive non contrast head CTs acquired on GEHC Discovery CT750HD, using our clinically-routine reduced-dose protocol (120 kV, 200 mA) were included in this study. For each scan, images without ASIR reconstruction were analyzed and compared to images reconstructed at 5 different levels of ASIR (20%, 40%, 60%, 80% and 100%). Region-of-interest (ROI) measurements of CT attenuation (HU) were acquired over normal gray matter (GM) and white matter (WM). Ten scans had a hypodense subacute infarct infarction over which additional ROIs were obtained (INF) and compared to contralateral normal tissue (NL). Signal-to-noise ratio (SNR), defined as mean attenuation over standard deviation, was calculated for each tissue region at each different ASIR level. Contrast-to-noise ratios (CNR) for GM-WM and INF-NL were calculated as the difference in mean attenuation for the two regions divided by the square root of the sum of their squared standard deviations. One-way variance analysis (Tukey's post hoc test) was used to determine statistical significance ($p < 0.05$).

RESULTS:
For GM, WM, INF and NL regions, SNR increased from 8.64, 6.81, 4.41, and 7.56, respectively, without ASIR, to 14.98, 11.58, 7.26, and 10.94 at 100% ASIR (p <.05). GM-WM and INF-NL CNRs increased from 1.34 and 2.49 without ASIR, to 2.93 and 4.54 at 100% ASIR (p<.05). SNR and CNR improvements from ASIR can be attributed primarily to reduction in image noise, as progressive ASIR levels were not observed to raise HU attenuation.

CONCLUSION
Adaptive Statistical Iterative Reconstruction is a tool that may enable significant radiation dose reduction of head CTs with preserved image quality by substantially reducing image noise.

ECR 2010

Lower radiation dose adaptive statistical iterative reconstruction head CT examinations match quality of prior conventional dose studies

E. G. Stein, P. S. Pawha, B. N. Delman, L. N. Tanenbaum; New York, NY/US

PURPOSE: Frequency of CT imaging and radiation dose to the population due to medical imaging are increasing (Figure 1 and 2). Some models project as many as 15,000 additional deaths due to induced cancers from medical radiation (1). It should be the goal of radiologists to minimize the radiation dose from a study while still providing images adequate for diagnostic evaluation. Adaptive statistical iterative reconstruction (ASIR) is a recently available reconstruction technique that, compared to filtered back projection (FBP) methods typically used in CT, provides a reduction in image noise and improvement in low contrast detectability (2).

METHOD AND MATERIALS:
We retrospectively reviewed the head CT examinations performed at our institution using the ASIR technique between April and October 2009. We found 42 scans performed with low radiation dose and ASIR on 38 patients. These patients also had 63 additional head CT exams that were performed with conventional radiation doses and FBP. (Figure 1) Radiation doses for all exams were determined either from the dose length product recorded at the time of the study or by estimation using ImPACT 0.99x (Impact, London). The ASIR and FBP reconstructed images were quantitatively assessed for noise by measuring the standard deviation of HU in a 1 cm ROI in the right centrum semiovale. Qualitative assessment of each study for overall quality and grey-white distinction was performed on a 4-point scale by three fellowship-trained neuroradiologists blinded to the reconstruction method. The same 3 reviewers examined ASIR and FBP exams side-by-side (blinded to the reconstruction method) at W=90, L=40 and were asked which exam had better greywhit distinction.

RESULTS:
Average radiation dose was reduced by 29% from 769 mGy•cm (FBP) to 546 mGy•cm (ASIR), p=0.0001. (Figure 1) Image noise was unchanged between the FBP and the ASIR reconstructed images. (Figure 1) Four example comparisons are provided. (Figure 2-5) There was no statistical difference between the scores given for overall quality (2.1 v. 2.3, p=0.1) or for grey-white differentiation (2.1 v. 2.1, p=1.0) by the three evaluating neuroradiologists. (Figure 6) When shown the current and prior exams from the same patient side-by-side, blinded to the reconstruction technique, the evaluating neuroradiologists demonstrated no consistent preference for the results provided by one technique versus the other. (Figure 7)

CONCLUSION
When compared to prior Head CT examinations performed on the same patient using conventional technique and FBP reconstruction, **ASIR permitted a 30% reduction in radiation dose without compromising grey-white distinction** or the overall quality of the study.

ECR 2011

Evaluation of dose reduction in 64-row CT of the cervical spine with adaptive statistical iterative reconstruction (ASIR) using standard clinical protocols

M. Körner, R. Hempel, S. Wirth, M.F. Reiser, U. Linsenmaier; Munich/DE

PURPOSE: To evaluate radiation exposure from 64-row CT examinations of the cervical spine using adaptive statistical iterative reconstruction (ASIR) compared to standard filtered back projection (FBP) raw data processing

METHOD AND MATERIALS:
64-row C-spine CT with a standard clinical protocol of 67 studies (mean age 55 ± 20 y, 30 males, 37 females) with FBP (LightSpeed VCT XT, GE Healthcare, Waukesha, WI) was retrospectively compared to 80 studies (50 ± 20 y, 49 males, 31 females) with ASIR (Discovery 750HD, GE Healthcare). The scan parameters for both examinations were identical (120 kV, dose modulation, 0.625 mm collimation, pitch 0.531:1) but the noise index (NI) was increased from 5 to 25 with an ASIR level of 30 %. From the dose reports generated automatically, the scan length, CTDI, and DLP were recorded. Statistical tests were performed with the Mann-Whitney U test.

RESULTS:
In the FBP group, mean CTDI was 21.43 (±1.43 standard deviation), scan length was 186.30 mm (±23.60), and DLP was 441.15 mGy*cm (±51.73). In the ASIR group, CTDI was 9.57 (±3.36), scan length was 195.21 mm (±26.82), and DLP was 204.23 mGy*cm (±68.01). The differences were significant for CTDI and DLP ($p < 0.001$) and scan length ($p = 0.013$). Estimation of mean effective dose resulted in 2.38 mSv in the FBP group and 1.10 mSv in the ASIR group. All images were of diagnostic quality as routine clinical acquisition protocols were used.
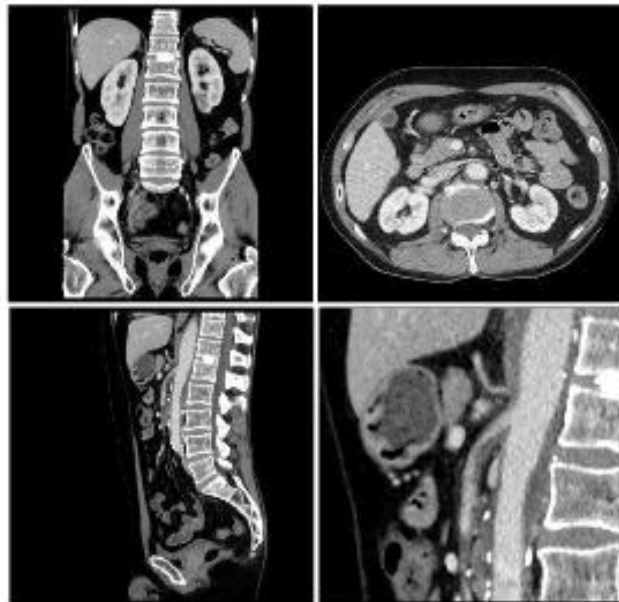
CONCLUSION
Dose reduction of about 50 % can be achieved with the use of ASIR for 64-row CT of the cervical spine in standard clinical protocols.

CLINICAL RELEVANCE/APPLICATION
ASIR is a likely tool for preserving image quality as we move toward CT examinations with lower radiation dose.

ABDOMEN-PELVIS IMAGING

RSNA 09

Optimization of Radiation Dose Exposure with Utilization of Adaptive Statistical Iterative Reconstruction (ASIR): Initial Experience

Ashish Sharma, MBBS – Abstract Co-Author, Priyanka Prakash MBBS, Avinash Kambadakone R, MD, FRCR, Mannudeep Kalra,MD, Michael Blake, MBBCh, Dushyant Sahani, MD (MGH)

PURPOSE: To study the impact of ASIR on the image quality and radiation dose in abdominal CT exams.

METHOD AND MATERIALS:
In this IRB approved study, 300 patients (age range 10-91 yr, M/F=136/164) underwent routine MDCT (CT750 HD, GE) of abdomen using ASIR mode (range: SS20-SS60). For MDCT scans with ASIR, ATCM with NI -12-20 was used and for FBP technique ATCM with 12-15 was selected. The scan parameters included 1.375:1 pitch, 120 kVp, 55 mm table feed per rotation and, 5 mm section thickness. The images were evaluated for subjective quality (IQ) (score 1-5), image noise (scale 1-5), contrast, sharpness and artifacts. The scan length and effective radiation dose (mSv) was estimated. In 112 patients abdominal CT performed using filtered back projection (FBP) image reconstruction were used for comparison with their ASIR enabled scans.

RESULTS:
IQ was scored adequate to excellent (range 3-5) in all ASIR enabled CT. The effective radiation dose was estimated to be reduced for all weight categories (range of 2.3 to 17.8 mSv, mean 9.3 mSv, SD ± 3.5 mSv). In patients < 30 yrs significant dose reduction was achieved (mean 9.6 mSv, p–value < 0.05). In the 112 patient's cohort with ASIR and FBP, significantly lower dose was observed in ASIR enabled scans (dose reduction range 0-70.4 %, mean 29.2 %. p-value <0.05).

CONCLUSION
ASIR enabled CT exam provides optimal image quality with substantial radiation dose benefits for routine abdomen imaging.

CLINICAL RELEVANCE/APPLICATION
ASIR software provides optimal image quality for scan acquisition at low radiation dose. This heralds its safer and feasible utilization in young patients and those requiring frequent CT examinations.

Image Quality and Radiation Dose in Patients with Large Body Habitus on MDCT Images Reconstructed with Adaptive Statistical Iterative Reconstruction (ASIR)

Ashish Sharma, MBBS – Abstract Co-Author, Avinash Kambadakone R, MD, FRCR, Michelle Doyle, RT, Joseph Fay, Raul Uppot, MD, Dushyant Sahani, MD (MGH)

PURPOSE: To analyse the effect of ASIR on MDCT Image Quality (IQ), Diagnostic performance and radiation dose in patients weighing >/= 200 lbs.

METHOD AND MATERIALS:
In this prospective, IRB approved study 46 patients (M: F-27:19, mean age: 57) weighing >/= 200 lb (mean: 229 lb, range: 200–350 lb) underwent single phase (portal venous) abdominal CT exam on 64-MDCT (Discovery CT750 HD, GE) with ASIR mode (30%-60%). IQ was subjectively analyzed by two blinded readers based on image quality (Scale 1-5), image noise (scale 1-5), sharpness, contrast and artifacts (score 1-5). Effective radiation dose was estimated in mSv. Comparative analysis for IQ and radiation dose benefits was drawn between ASIR versus Filtered Back Projection (FBP) CT exams with comparable scan parameters in 14 patients

RESULTS:
IQ was found to be adequate to excellent (score 3-5) in all ASIR-CT and was superior or comparable to FBP-CT. Average radiaton dose in ASIR-CT was 11.8 mSv (range: 5.8-17.8mSv±2.7mSv) versus FBP-CT

(mean: 17.5mSv, range: 12.5-27.7mSv±4.6mSv). **Average radiation dose reduction between ASIR versus FBP-CT was estimates as 31.3 %** (range: 5.4-52.2% ± 15%, pvalue: < 0.05).

CONCLUSION
MDCT images reconstructed using ASIR provides better image quality and tissue density differentiation in abdomen and pelvis in addition to lowering radiation dose by 30% in comparison to FBP-CT images

CLINICAL RELEVANCE/APPLICATION
Image quality degradation lowering diagnostic confidence and excessive radiation dose are common issues in MDCT of patients with large body habitus. ASIR enabled CT reliably meets the dual objectives.

Effect of an Adaptive Statistical Iterative Reconstruction Algorithm on Image Noise and Detection of Hypervascular Liver Tumors Using a Low Tube Voltage,High Tube Current MDCT Technique

Daniele Marin, MD – Abstract Co-Author, Rendon Nelson, MD, Sebastian Schindera, MD, Antonino Guerrisi, MD, Erik Paulson MD, Daniel Boll, MD (Duke)

PURPOSE: To intraindividually investigate whether an adaptive statistical iterative reconstruction (ASIR) algorithm can decrease image noise and improve the detection of malignant hypervascular liver tumors using a low tube voltage (80kVp), high tube current (675mA) CT technique at abdominal MDCT during the late hepatic arterial phase.

METHOD AND MATERIALS:
The institutional review board approved this HIPAA-compliant, retrospective study, and a waiver of informed consent was obtained. The study cohort comprised 32 patients (18 men, 14 women; age range, 35-78 years) with 50 malignant hypervascular liver tumors (mean diameter, 17±8mm) who underwent an abdominal dual energy, 64-slice MDCT scan (LightSpeed VCT; GE Healthcare) during the late hepatic arterial phase. By using a vendor-provided software (Volume Dual Energy; GE Healthcare), two separate imaging settings (80kVp/540mAs and 140kVp/308mAs) were acquired nearly simultaneously. The low energy (80kVp) image set was processed with both the standard filtered backprojection (FBP) reconstruction algorithm and the ASIR algorithm (GE Healthcare) at 20, 40, 60, and 80 noise reduction level sets. The average image noise and lesion-to-liver contrast-to-noise ratio (CNR) for each lesion were measured and compared among different image sets. The analysis of variance (ANOVA) test was performed for verification of statistically significant differences (P<0.05).

RESULTS:
The average image noise on the ASIR algorithm image sets (17.1±3.9HU, 14.2±2.7HU, 11.9±2HU, and 9.7±1.3HU at 20, 40, 60, and 80 noise reduction level sets) **was significantly lower compared to the standard FBP algorithm image set** (20±5HU) (P<0.001). This resulted in significantly higher average lesion-to-liver CNR on the ASIR algorithm image sets (3.7±1.8, 4.2±2.2, 5.1±2.3, and 6.1±2.6 at 20, 40, 60, and 80 noise reduction level sets) compared to the CNR on the standard FBP algorithm image set (3.1±1.9) (P<0.001).

CONCLUSION
Compared to a standard FBP algorithm, the ASIR algorithm significantly decreases image noise of a low energy (80 kVp) CT technique, which results in improved conspicuity of malignant hypervascular liver tumors during the late hepatic arterial phase.

CLINICAL RELEVANCE/APPLICATION
By substantially decreasing image noise, the ASIR algorithm improves the conspicuity of malignant hypervascular liver tumors using a low energy CT technique.

Achieving Optimal Balance between Radiation Dose and Image Quality in Preoperative CT Evaluation of Living Liver and Renal Donors

Avinash Kambadakone R, MD, FRCR – Abstract Co-Author, Naveen Kulkarni, MD, Anand Singh, MD, Martin Hertl, Dushyant Sahani, MD

PURPOSE: To study the image quality and radiation dose implications of Adaptive statistical iterative reconstruction (ASIR) and filtered back projection (FBP) reconstructive techniques in liver and renal donors undergoing preoperative MDCT examinations

METHOD AND MATERIALS:
In this ongoing IRB approved study, 30 patients (Age range 27-56yrs, 21M: 9F) underwent 64-MDCT scan for preoperative evaluation using ASIR (n=15) and FBP (n=15) reconstruction techniques. The CT technique included unenhanced CT, CTA, and CT cholangiogram/ CTU. The contrast media dose and injection protocols were similar in the two groups. Two blinded readers assessed the CT studies for image quality (IQ, 1-5 scale) of 2D and 3D display, image noise (N, 1-5 scale), visualization of vascular branch order and graded on a 5 point scale. Effective dose and image quality was compared using student's t-test for statistical significance.

RESULTS:
The image quality for 2D and 3D display were with HRCT-ASIR was rated slightly better as compared to the FBP-CT (4.2 vs 3.8, p=0.05). The branch order visualization was 5th order with ASIR and 4th order with FBP-CT. The ASIR reconstruction technique resulted in an average radiation dose reduction of 35-54% of CTDIvol and effective dose compared to FBP-CT (Student's t-Test p=0.0003).

CONCLUSION
MDCT with ASIR reconstruction enables high quality exams for comprehensive assessment of living liver-renal donors at a substantially lower radiation dose compared to MDCT with FBP.

CLINICAL RELEVANCE/APPLICATION
Imaging is integral in pre-operative evaluation of liver-renal donors to define vascular-biliary-urographic anatomy. ASIR allows improved image quality with significant radiation dose reduction

Effect of Body Mass Index on Image Quality and Dose Reduction for Low Dose Abdominal CT Using Adaptive Statistical Iterative Reconstruction (ASIR)

Yoshiko Sagara, MD – Abstract Co-Author, Amy Hara, MD, Alvin Silva, MD, Robert Paden, Qing Wu, William Pavlicek, PhD (Mayo Clinic – Scottsdale)

PURPOSE: To evaluate the effect of body mass index (BMI) on image quality and dose reduction for abdominal low dose (LD) CT reconstructed with Adaptive Statistical Iterative Reconstruction (ASIR)

METHOD AND MATERIALS:
Fifty seven patients (39M, 18F, mean age=61.6 yrs) underwent contrast-enhanced LD abdominal CT exams on a 64-row detector scanner. Each LD exam was reconstructed using iterative reconstruction for noise reduction (ASIR). All patients also had a routine dose (RD) contrast-enhanced exam for comparison.
Two radiologists independently graded LD with ASIR and RD images in the same patients while blinded to the scanning technique. Sharpness, image noise, and diagnostic acceptability was graded from 1 (unacceptable)-5 (superior) and beam hardening from 1 (unacceptable)-3 (absent). Both radiation dose and image quality measurements were compared by dividing patients into three groups based on BMI: > 25 BMI (n=36), between 20 and 24.9 BMI (n=14), and < 20 BMI (n=7). Quantitative background noise measurements were also obtained.

RESULTS:
The CTDI for LD with ASIR ranged from 5 to 13 for BMI < 20 (**66% reduction** compared to RD), 9 to 24 for BMI between 20 and 24.9 (**44% reduction**), and 9 to 31 for BMI > 25 (**23% reduction**). Qualitative and quantitative grading of image noise varied depending on BMI. For small patients with BMI <20, LD with ASIR

images were graded as slightly more noisy than RD (2.5 vs. 2.8, p=0.27). Conversely, in larger patients with BMI > 25, LD with ASIR images were graded as having less noise than RD (3.2 vs 2.6, p<.0001). The background noise measurements of LD with ASIR (average=29, range 6-73) were slightly lower than RD (average 36, range 7-87) regardless of BMI (p=0.04).

Diagnostic acceptability of LD with ASIR was superior to RD (3.1 vs 2.9, p=.0003) if the BMI was > 25, but nearly identical for all other patients. Beam hardening was nearly identical between LD with ASIR and RD regardless of BMI. Qualitative assessment of sharpness was worse using LD with ASIR compared to RD exams for all BMI groups.

CONCLUSION
CT radiation dose reductions using ASIR range from 23% for BMI > 25 to 66% for BMI < 20. Image noise is reduced and diagnostic acceptability improved even using a lower radiation dose in patients with BMI > 25 when ASIR is applied to LD CT images.

CLINICAL RELEVANCE/APPLICATION
Dose reductions and image quality vary depending on BMI and should be considered when developing low dose imaging protocols.

Low dose abdomen imaging on the HDCT with new gemstone detector and new reconstruction algorithm (ASIR, adaptive statistical iterative reconstruction)

G. Lo1, J. Chan1, C. Lau1, S. K. Yu1, Y. Shen2, Y. Guo2; 1Hong Kong/CN, 2Beijing/CN

PURPOSE: High definition computed tomography (HDCT) is capable to provide high quality and low radiation dose imaging with new gemstone detector and new reconstruction algorithm (ASIR). The purpose of this study was to evaluate the effect of ASIR on radiation dose and image quality in CT abdomen imaging using HDCT.

METHOD AND MATERIALS:
Fifty consecutive patients underwent abdomen scan on HDCT scanner with auto-adjusted mA (Noise Index adjusted by Body Mass Index: 22~28) were included in this study. Axial images were reconstructed with and without ASIR algorithm. The radiation dose was recorded and the image quality was evaluated in a double-blind manner by two radiologists using a 5-point scoring system (excellent: 1;bad: 5). The noise level (standard deviation of CT values) in different tissue was also measured. Statistical t test analysis on image quality score and noise of axial images were performed.

RESULTS:
The average radiation dose was 4.32+/-1.92 mSv. The average image quality score (from hepatic vein, portal vein, pancreas, Bifurcation level) in ASIR group (2.17+/-0.38) was statistical better (p < 0.05) than the non-ASIR group (2.62+/-0.60). The average noise level of different tissue was also statistical significantly lower in ASIR group (Liver: Av =13.56; Vein: Av =16.17; Bone: Av = 29.82; Kidney: Av = 16.62) than in the non-ASIR group (Liver: Av =16.88; Vein: Av =19.91; Bone: Av = 32.86; Kidney: Av = 19.59). The percentage decrease in image noise of axial view was 20% in liver, 19% in vein, 9% in bone and 15% in kidney. It was also found that the noise reduction is more effective for thinner slice thickness.

CONCLUSION
The HDCT can provide more diagnosis information and more consistent image quality with ASIR algorithm**. Since the image noise can be effectively reduced by ASIR, it allows a significant reduction of radiation dose in CT abdomen imaging.**

What is the high definition HDCT's advantage: Review of phantom result and abdomen clinical experience

G. Lo1, J. Chan2, C. W. Lau2, S. K. Yu2, Y. Shen3, Y. Guo3; 1Hong Kong/HK, 2Hong Kong/CN, 3Beijing/CN

LEARNING OBJECTIVES: 1. Introduce the gemstone detector, CT sampling technique and the ASIR reconstruction algorithm and their advantage in High Definition image.2. Demonstrate the advantages and applications in low dose CT imaging.

BACKGROUND:
1 Discovery™ CT750 HD (HDCT)has a new gemstone detector that is 100 times faster at its core, which would enable higher sampling rates to contribute to higher image quality.2 The re-designed Data Acquisition System (DAS), which manages the amount the information in the reconstruction process, harvests more views to create an image.3 A new X-ray tube was also necessary, which provide dynamic focal spot control and higher mA focal spots for better image quality in larger-sized patients. 4 And last, a new Adaptive Statistical Iterative Reconstruction (ASIR) algorithm to increase low contrast detectability up to 40%, in order to suppress artifact, contributes to dose reduction by up to 50%.

Imaging findings OR Procedure details:
1. The spatial resolution at the center of the FOV was significant better in HDCT (0.47mm) with ASIR than in Non-HDCT (0.69mm). It degrades across the FOV to 0.53 mm (13%) at 10cm off-center in HDCT and of a greater extent to 0.84 mm (22%) in Non-HDCT.2. HDCT provides more diagnosis information and consistent image quality with ASIR. The percentage decrease of image noise in axial view was from 9% to 20% in different tissue.3. The average radiation dose was 4.32+/-1.92 mSv. The average image quality score (from hepatic vein, portal vein, pancreas, Bifurcation level) in ASIR group (2.17+/-0.38) was statistical better (p < 0.05) than the non-ASIR group (2.62+/-0.60).The average noise level of different tissue was also statistical significantly lower in ASIR group than in the non-ASIR group.The percentage decrease in image noise of axial view was 20% in liver, Page 3 of 6 19% in vein, 9% in bone and 15% in kidney.It was also found that the noise reduction is more effective for thinner slice thickness.

CONCLUSION
Radiation dose in abdomen CT imaging can be greatly reduced **while maintain good image quality with gemstone detector, CT sampling technique and the** reconstruction algorithm named ASIR **technique in HDCT.**

Can we have CT colonoscopy screening in less than 1mSv radiation dose on high definition computed tomography?

G. Lo1, J. Chan2, C. Lau2, S. K. Yu2, Y. Shen3, Y. Guo3; 1Hong Kong/HK, 2Hong Kong/CN, 3Beijing/CN

PURPOSE: High definition computed tomography (HDCT) is capable to provide high quality and low radiation dose imaging with new gemstone detector and new reconstruction (ASIR) algorithm. The purpose of this study was to evaluate the effect of ASIR on radiation dose and image quality in CT colonoscopy screening using HDCT.

METHOD AND MATERIALS:
Six consecutive patients underwent CT colonoscopy scanning on HDCT with auto-adjusted mA (Noise Index: 70).Axial and reformat images were reconstructed with and without ASIR.The radiation dose was recorded and the image quality was evaluated in a double-blind manner by two radiologists using a 5-point scoring system (excellent: 1;bad: 5).The noise level (standard deviation of CT values) in different tissue was also measured.Statistical t test analysis on image quality score and noise of the axial images were performed.

RESULTS:
The average radiation dose was 0.84+/-0.31 mSv.The average image quality score (at
Ascending Aorta,Pulmonary Artery,Descending Aorta level) in ASIR group (2.28+/-0.44) was statistically significant better ($p < 0.05$) than the non-ASIR group (3.28+/-0.57).There was statistically difference on reformat image scores between ASIR and non-ASIR group, but no statistically difference was found on navigation image scores.The average noise level of different tissue was statistical significantly lower in ASIR group than in the non- ASIR group.The percentage decrease in image noise of air inside the colon, kidney tissue, vertebral column and reformat image was 31%,33%,22% and 32%, respectively.

CONCLUSION
The HDCT can provide more diagnosis information and more consistent image quality with ASIR algorithm.Using HDCT with ASIR, the radiation dose of CT colonoscopy can be reduced to lower than 1mSv.

CLINICAL RELEVANCE/APPLICATION
Based on a phantom study, the Adaptative Statistical Iterative Reconstruction allows 32-65% dose reduction for identical overall image quality.

Radiation Dose Reduction in MDCT of Patients with Crohn's Disease Using Iterative Reconstruction Techniques

Avinash Kambadakone R, MD, FRCR – Abstract Co-Author, Ashish Sharma, MBBS, Mukta Joshi, Deanna Nguyen, MD, Bruce Sands, MD, Dushyant Sahani, MD (GE, MGH)

PURPOSE: To evaluate the image quality and diagnostic acceptability of low dose CT examinations reconstructed with Adaptive statistical iterative reconstruction (ASIR) in patients with Crohn's disease (CD) and to assess the radiation dose benefits

METHOD AND MATERIALS:
19 patients (mean age-28yrs, range 18-68yrs, 9M: 10F) of Crohn's disease (CD) who underwent low dose contrast enhanced 64 MDCT scan (Discovery CT750 HDCT, GE Healthcare) for evaluation of CD activity were included in this ongoing IRB approved study. In 10 patients, previous CT studies performed with filtered back projection (FBP) were also included for comparison. The low dose scan protocol included 120kVp, automated tube current modulation (ATCM) with noise index, NI (20) with ASIR (range 20%-60%), while the standard protocol included 120kVp and ATCM with NI-12-15. The images were reviewed by 2 readers for subjective assessment of image quality (IQ, 1-5 scale) (axial and coronal reformations), image noise (N, 1-5 scale), mural changes, extramural findings and complications. The radiation dose data (CTDI, DLP and effective dose) was recorded for all CT studies. The final confirmation of disease activity and complications was based on clinical evaluation /follow up imaging/endoscopy and surgery.

RESULTS:
Out of the 29 CT studies included for analysis 25/29 scans (86%) demonstrated positive findings and in 9/29 (31%) exams complications (Abscess-6, fistula -2, stricture-2) were seen. **The image quality and image noise of CT images reconstructed with ASIR were better than those with FBP** (IQ: 4.3 vs 3.8, N 1.6 vs 1.7, p=0.05). **The average radiation dose reduction achieved with ASIR technique was 39.5%** (range 6-58%) compared to FBP technique (ASIR: 5.6 ± 2.6mSv, FBP: 7.7 ± 3mSv) (p=0.005).

CONCLUSION
Low dose CT examinations with ASIR Technique provide substantial radiation dose reduction in patients with Crohn's disease with improved image quality and diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION
Performing low dose CT examinations with ASIR technique has considerable radiation dose benefits with comparable diagnostic accuracy particularly in young patients who undergo multiple CT examinations

ECR 10

Low dose abdomen imaging on the HDCT with new gemstone detector and new reconstruction algorithm (ASIR, adaptive statistical iterative reconstruction)

G. Lo1, J. Chan1, C. Lau1, S.K. Yu1, Y. Shen2, Y. Guo2; 1Hong Kong/CN, 2Beijing/CN

PURPOSE: The purpose of this study was to evaluate the effect of ASIR on radiation dose and image quality in CT abdomen imaging using High definition computed tomography (HDCT)

METHOD AND MATERIALS:
Fifty consecutive patients underwent abdomen scan on HDCT scanner with auto-adjusted mA (Noise Index adjusted by Body Mass Index: 22~28). Axial images were reconstructed with and without ASIR algorithm. The radiation dose was recorded and the image quality was evaluated in a doubleblind manner by two radiologists using a 5-point scoring system (excellent: 1; bad: 5). The noise level (standard deviation of CT values) in different tissue was also measured. Statistical t test analysis on image quality score and noise of axial images were performed

RESULTS:
The average radiation dose was $4.32 \bullet \} 1.92$ mSv. The average image quality score (from hepatic vein, portal vein, pancreas, Bifurcation level) in ASIR group ($2.17 \bullet \} 0.38$) was statistical better ($p < 0.05$) than the non-ASIR group ($2.62 \bullet \} 0.60$).
The average noise level of different tissue was also statistical significantly lower in ASIR group than in the non-ASIR group. The percentage decrease in image noise of axial view was 20% in liver, 19% in vein, 9% in bone and 15% in kidney. It was also found that the noise reduction is more effective for thinner slice thickness.

CONCLUSION
The HDCT can provide more diagnosis information and more consistent image quality with ASIR algorithm. Since the image noise can be effectively reduced by ASIR, it allows a significant reduction of radiation dose in CT abdomen imaging

RSNA 10

Can Adaptive Statistical Iterative Reconstruction Technique Improve Image Quality and Decrease Radiation Dose on Abdomen CT Scan Compared with Traditional FBP Algorithm

Xinjiang Wang MD (Presenter) Ping Hui, Yanyan Wang, Cheng Zhou MD, Huizhi Cao, Yun Shen PhD

PURPOSE: To investigate whether an adaptive statistical iterative reconstruction (ASIR) technique improves the image quality and reduce radiation dose at different tube-voltage multidetector abdominal computed tomography (CT).

METHOD AND MATERIALS:
62 consecutive patients underwent abdominal CT scan were enrolled. Sixty patients (thirty-eight men, twenty-four women; mean age, 56 years; age range, 31-72 years) known or suspected to have hypervascular liver tumors underwent HDCT(Discovery CT750 HD, GE Healthcare). Different scan parameters was selected based on patient's body mass index(BMI): 100kVp,500mA (BMI≤24) and 120kVp,300mA (BMI>24). Standard FBP and ASIR were both used to reconstruct image sets. The mean image noise; contrast-to-noise ratio (CNR)relative to muscle for the aorta, liver, and pancreas; and effective dose were assessed. A figure of merit (FOM) was computed to normalize the image noise and CNR to effective dose.

RESULTS:

When image noise was normalized to effective dose, ASIR at 120kVp and 100kVp both yielded significantly reduction (P <0.001) in noise compared with FBP at 120kVp and 100kVp. For group 120kVp and 100kVp, ASIR was associated with an overall mean noise decrease of 22.3% and 25.2% respectively, compared with FBP. When the CNR was normalized to effective dose, ASIR yielded significantly higher CNRs for the aorta, liver, and pancreas than that of FBP (P <0.001 for both 120kVp and 100kVp).

CONCLUSION

Compared with standard FBP reconstruction, **an ASIR algorithm improves image quality and has the potential to decrease radiation dose** at different tube-current multidetector abdominal CT scan.

CLINICAL RELEVANCE/APPLICATION

ASIR reconstruction algorithm is a promising technique for providing diagnostic quality CT images at significantly reduced radiation doses

ECR 2011

The use of iterative reconstruction in ultra low dose computed tomography for bodypacker screening

K. H. Nieboer1, N. Buls2, J. de Mey3, G. Van Gompel2; 1Schaarbeek/BE, 2Brussels/BE, 3Brussel/BE

PURPOSE: For bodypacker screening, volume imaging is superior to abdominal radiography, which creates superposition and a larger fraction of false negative results. A typical drawback of CT is the higher associated radiation dose, which could however be reduced by recently introduced iterative reconstruction methods. The purpose of this study was to investigate the feasibility of an ultra low dose computed tomography (ULD-CT) scan protocol in the search of drugs in bodypacker suspects.

METHODS AND MATERIALS:

27 suspects were scanned with a ULD protocol on a General Electric Discovery 750 HD system. The scan protocol was derived by adjusting our standard CT abdomen protocol with reduced exposure parameters and the introduction of iterative reconstruction. Images were reviewed for the presence and total number of drug packages. Organ-and effective doses were determined by internal thermoluminescent dosimetry (TLD) in a humanoid phantom with 200 individually calibrated TLD's. Doses were calculated according recent ICRP-103 recommendations.

RESULTS:

The ULD protocol applied a reduced tube voltage of 100 kV and increased noise index of 70. All projection data were iteratively reconstructed. From the 27 suspects 17 were found to be positive. Every individual drug package was easily detectable which was confirmed by excretion. The effective dose of the ULD scan ($CTDI_{vol}$ = 1,7 mGy) was found to be 1,4 mSv for a standard size patient, compared to 10,4 mSv for a standard diagnostic CT-scan ($CTDI_{vol}$ = 12,7 mGy).

CONCLUSION

ULD-CT with iterative reconstruction can help in making CT bodypacker screening safer without loosing its efficacy

Dose reduction in 64-row whole-body trauma CT: initial experience with Adaptive Statistical iterative Reconstruction (ASIR)

M. Körner, A. Harrieder, S. Wirth, M.F. Reiser, U. Linsenmaier; Munich/DE

PURPOSE: To evaluate radiation exposure of 64-row whole-body CT in patients with major trauma using ASIR.

METHOD AND MATERIALS:

ASIR is a CT raw data processing method that compensates image noise more effectively than conventional filtered back projection (FBP), consequently allowing for reduction of exposure. Dose reports of 64-row whole-body trauma CT (head to symphysis) of 105 studies (72 males, 33 females) with FBP (LightSpeed VCT XT, GE Healthcare, Waukesha, WI) were retrospectively compared to 81 studies (52 males, 29 females) with ASIR (Discovery 750HD, GE Healthcare). The scan parameters for both examinations were identical but the noise index (NI) was increased from 5.2 to 6.0 (head) and 29.0 to 46.0 (chest, abdomen and pelvis) with an ASIR level of 30 % (head) and 50 % (chest, abdomen and pelvis). Scan length, CTDI, and DLP were tested for statistical difference with the Mann-Whitney-U test.

RESULTS:

The mean CTDI for head, chest, and abdomen was significantly lower with ASIR (FBP: 53.8 ± 2.1 (standard deviation), 10.3 ± 2.5, 14.2 ± 3.7; ASIR: 48.7 ± 2.2, 6.7 ± 2.2, 8.0 ± 3.5, $p < 0.001$). The mean DLP for head, chest, and abdomen was significantly lower with ASIR (FBP: 1308.55 ± 202.0, 505.4 ± 135.4, 836.0 ± 250.1; ASIR: 1189.3 ± 162.8, 342.9 ± 124.4, 572.4 ± 234.6, $p < 0.001$). There was a significant increase in the mean scan length of the abdomen from 519.7 ± 50.6 to 681.8 ± 263.9 cm with ASIR ($p < 0.001$). Total mean dose estimation was 24.1 mSv (FBP) and 17.1 (ASIR), resulting in a reduction of 30 %.

CONCLUSION

64-row whole-body trauma CT with ASIR helps to significantly reduce exposure dose to the patients by 30 % in comparison to CT with FBP.

Image quality and dose saving aspects of adaptive statistical iterative reconstruction (ASIR) in 64-row abdominal CT imaging

S. Wirth, F. Mück, M. Körner, L. Brummund, M. Scherr, U. Linsenmaier, J. Grimm, M. Treitl, M.F. Reiser; Munich/DE

PURPOSE: To compare 64-row abdominal CT at different levels of ASIR to prior examinations with filtered back-projection (FBP) in regard to image quality and dose saving potential.

METHOD AND MATERIALS:

24 patients with abdominal 64-row CT (LightSpeed VCT XT, GE) as reference examination and a follow-up study on a CT with ASIR option (Discovery 750HD, GE) were included. The noise index was increased from 29 (reference) to 43 (follow-up's) with other relevant scan parameters held constant. Images (5mm ax, 3 mm sag and cor; standard kernel) were reconstructed using different ASIR levels (0, 30, 50, 70, and 100 %, slice and volume mode). 2 experienced radiologists performed consensus reading with respect to image quality regarding soft tissue evaluation in comparison to the reference (-2:clearly inferior, -1:inferior, 0:equal, +1:superior, +2:clearly superior). The Mann-Whitney-U-test was used for statistical testing.
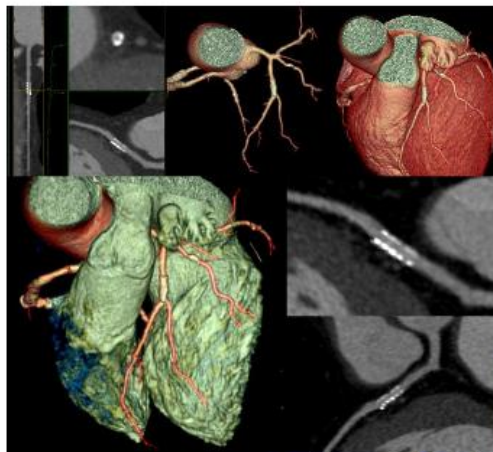
RESULTS:
ASIR 30 and 50 performed equal to the reference (mean -0.1; $p > 0.05$), ASIR levels of 0 or 100 % were rated inferior (-0.3 and -0.7; $p < 0.01$) without significant differences for slice and volume mode ($p > 0.05$). ASIR 70 volume mode performed equal to ASIR 30 and 50-slice mode (0.0; $p > 0.05$) while ASIR 70 slice mode was inferior (-0.2; $p < 0.05$). Mean CTDI of the follow-up studies decreased significantly from mean 19.8 ± 5.3 to 11.9 ± 4.6 mGy ($p < 0.01$). Mean effective dose was reduced to 9mSv.

CONCLUSION
Image reconstruction with ASIR levels of 30 or 50 in slice mode allows for dose savings of 40 % without significant loss of image quality. Time-consuming volume ASIR showed no additional benefits.

ANGIOGRAPHY IMAGING

ECR 2010

Why HDCT can provide low dose CT angiography imaging?

G. Lo1, J. Chan2, C. W. Lau2, S. K. Yu2, Y. Shen3, Y. Guo3; 1Hong Kong/HK, 2Hong Kong/CN, 3Beijing/CN

LEARNING OBJECTIVES: 1. Introduce the gemstone detector and the AIR reconstruction algorithm.2. Demonstrate the advantages and applications in low dose CT angiography imaging.

BACKGROUND:
1 Discovery™ CT750 HD (HDCT)has a new gemstone detector that is 100 times faster at its core, which would enable higher sampling rates to contribute to higher image quality.
2 The re-designed Data Acquisition System (DAS), which manages the amount the information in the reconstruction process, harvests more views to create an image.
3 A new X-ray tube was also necessary, which provide dynamic focal spot control and higher mA focal spots for better image quality in larger-sized patients.
4 And last, a new Adaptive Statistical Iterative Reconstruction (ASIR) algorithm to increase low contrast detectability up to 40%, in order to suppress artifact, contributes to dose reduction by up to 50%.

Imaging findings OR Procedure details S:
1. HDCT provides more diagnosis information and consistent image quality using ASIR. The average image quality score (at 3 different axial image level) in ASIR group and non-ASIR group was 1.3+/-0.32 and 1.7+/-0.4, respectively. The percentage decrease of image noise in axial view was 21% in ascending aorta, 21% in muscle and 9% in bone.
2. With gemstone detector and ASIR algorithm, the radiation dose of CT angiography imaging can be reduced to an average of 3.85+/-1.2 mSv.

CONCLUSION
Radiation dose on CT angiography imaging can be greatly reduced while maintain good image quality **with gemstone detector and ASIR algorithm.**

COURSES

RSNA 10

Taking Dose out of the Discussion: Modern Dose Reduction Techniques in Coronary CT Angiography

Hina Mumtaz MD, DNB (Presenter), Jennifer Ellis MD, Cameron Hague MD, Brett Heilbron MD, FRCPC, Carolyn Taylor MD, Jonathan Leipsic MD, Troy Labounty, James Min, James Earls MD

PURPOSE: Rapid advancement in CT technology has enabled robust non-invasive coronary artery assessment, with faster imaging techniques. It has also raised concerns for increased ionizing radiation exposure.
Radiologists must familiarize themselves with dose reduction techniques to ensure proper balance between image quality and radiation exposure.

CONTENT:
Appropriate patient screening in conjunction with thoughtful patient-specific scanning technique are critical to optimizing image quality while minimizing radiation dose. Key considerations include:
1. Appropriate patient selection
2. Heart rate control
3. Strategic Z-axis coverage
4. ECG-correlated tube current modulation
5. Tube voltage reduction
6. Prospective triggering: axial "step and shoot" scanning
7. Minimizing padding
8. **Newer iterative reconstruction algorithms**

SUMMARY:
Coronary CT angiography is a promising tool for integrated imaging of plaque morphology as well as stenosis detection and quantification. Coronary computed tomographic angiography (CCTA), however, is associated with ionizing radiation and a potential risk of future fatal and non-fatal cancer. As a result, radiologists must be aware of and should utilize all dose reduction techniques available to ensure that CCTA is performed in accordance with ALARA (As Low As Reasonably Achievable).

Update of Dose Reduction Strategies Using 64-Detector Cardiac CT Imaging

Masayuki Kudo RT (Presenter), Takamichi Murakami MD, PhD, Masahiro Okada MD, Yoshifumi Nakauchi MD, Koji Yamada RT, Yasufumi Shigeyoshi MD, PhD

PURPOSE: The aim of this exhibit is to compare image quality and their potential for dose reduction between different approaches for cardiac CT imaging using latest scan and reconstruction technique

CONTENT:
1. Overview of the current available application for dose reduction
a. ECG-dependant mA modulation
b. Step and shoot ECG triggering scan
c. Low tube voltage approach
d. **Adaptive Statistical Iterative Reconstruction**
e. Imaging filtering
f. Usage of beta-blocker
2. Prospective strategies for dose reduction
3. Post processing strategies for dose reduction
SUMMARY:
The major teaching points;
1. **Reconstruction algorithm** and imaging filter provide lower patient dose at high reliability.
2. The use of low kV technique is limited to obese patients.
3. The use of drug does not contribute to dose reduction directly, but the opportunities of dose reduction

increase by lowering heart rate.

4. The mA modulation and step and shoot scan allow the lowest dose, but suffer from inconsistent image quality. These techniques depend on patient's heart rate.

CT Perfusion Imaging in Abdomen Made Easy
Tetsuro Araki MD (Presenter), Sung-Woon Im, Masahiro Okada MD, Seishi Kumano MD, Masayuki Kudo RT, Takamichi Murakami MD, PhD

PURPOSE:
1. To define the protocol and analysis method of CT perfusion imaging. 2. To define the parameters of CT perfusion. 3. To define clinical interpretation of CT perfusion imaging in liver and pancreas.

CONTENT:
1. Basic protocol and mechanism of CTP. 2. Radiation reduction techniques: **CTP can't be without it. - Adaptive Statistical Iterative Reconstruction (ASIR)** 3. How to interpret the parameters -Blood flow(BF), Blood volume(BV), Mean transit time(MTT), permeability surface area product(PS) 4. Clinical interpretation of CTP in the Liver, pancreas -To estimate prognosis, evaluate therapy efficacy. -HCC, Hemangioma -Pancratic tumor, necrotic pancreatitis 5. Any other organs possible?

SUMMARY:
New radiation dose reduction techniques have enabled CT perfusion imaging into clinical use without extra-radiation exposure to patients, not only in brain, but also in abdomen. CT perfusion imaging is evaluated by several parameters, such as BF, BV, MTT and PS. The analysis and calculation of CT perfusion is not simple but the interpretation of these parameters is quite easy to handle. We also show some clinical cases of liver and pancreas tumor to help you understand how to handle CT perfusion imaging without difficulty.

Reducing Radiation Exposure in CT Perfusion Using New Advanced Reconstruction Method
Kazufumi Suzuki MD (Presenter), Ai Masukawa, Satoru Morita MD, Yun Shen PhD, Cheng Zhou MD, Eiko Ueno MD

PURPOSE:
Iterative reconstruction is a new advanced technique that reduces image noise and improves detectability of low contrast and image quality. The purpose of this exhibit is to learn how to evaluate and control radiation exposure in CT examination. We show clinical cases of brain stroke using the new technology.

CONTENT:
1. Technical notes
1.1. Evaluating CT dose
1.2. **Iterative reconstruction method**
2. Clinical CT procedure
2.1. Diagnostic procedure for acute brain stroke using CT perfusion
2.2. Managing exposure dose using a new algorithm

SUMMARY:
This exhibit reviews:
1. Basic knowledge of exposure management
2. **Technical hints for using iterative reconstruction with clinical images**

Achievable Dose Reduction in Children Requiring Diagnostic Imaging: Role of Adaptive Statistical ITERATIVE Reconstruction

Kazufumi Suzuki MD (Presenter), Ai Masukawa, Satoru Morita MD, Yun Shen PhD, Cheng Zhou MD, Eiko Ueno MD

PURPOSE:
1. To perform qualitative and quantitative assessment of computed tomography (CT) scans with application of Adaptive Statistical Iterative Reconstruction (ASiR) algorithm and compare it with retrospective imaging without ASiR. 2. To modify and implement protocols with reduced radiation dose required for optimal diagnostic imaging

CONTENT:
1. ASiR is an advanced image reconstruction algorithm that has the potential for a decrease in radiation dose without compromising image quality. 2. Optimal diagnostic quality scans can be achieved at lower dose. 3. Up to 67% dose reduction can be achieved without compromising image quality based on observational data collected from our institution. 4. Up to 83% dose reduction can be achieved for cardiac exams.

SUMMARY:
1. Dose reduction in diagnostic imaging is critical, especially in children as they are much more sensitive than adults. 2. Taking into consideration the risks and benefits of radiation in a clinical scenario, radiation exposure to the focused body area with use of ASiR and as low as reasonably achievable should be implemented. 3. Optimal diagnostic image quality should always be considered with application of ASiR

PHYSICS OF MEDICAL IMAGING

ECR 2010

Can ASIR technique of high definition computed tomography lower the noise: A phantom study

H. Cao, Y. Shen, Y. Guo; Beijing/CN

PURPOSE: To evaluate the ability of ASIR technique of high definition CT (HDCT) in lowering the noise by a pulmonary nodule phantom.

METHOD AND MATERIALS:
A pulmonary nodule phantom were scanned on HDCT (0.5s/r, pitch 0.516) with different radiation dose as follow: 250, 150, 50 and 10 mA respectively, at a fixed voltage of 120 kVp. HD lung algorithm and 50% ASIR (Adaptive Statistical Iterative Reconstruction) algorithm were used to reconstruct the images. And CT values, noise index of different nodules with various doses were measured by two experienced doctors independently.

RESULTS:
In There was no significant difference on mean CT value of nodules between images reconstructed with HD lung algorithm and with 50% ASIR algorithm (t=0.38, P=0.612), whereas the image noise index with 50% ASIR reconstruction algorithm at 250mA, 150mA, 50mA and 10mA was decreased by 34%, 33%, 36%, 33% respectively, compared with that of using HD Lung algorithm. The image noise level with 50% ASIR reconstruction algorithm at 50 mA was similar to that of the image with HD Lung algorithm at 150 mA.

CONCLUSION
ASIR technique of HDCT has obvious ability to lower noise without compromising CT value depiction. So the scanning mA can be reduced with equivalent noise using ASIR technique.

ECR 2011

Impacts of ASiR reconstruction on volumetric measurement with low-dose HDCT: phantom study

Z. Zhang1, Q. Wang1, T. Yu1, Y. Ying1, Z. Liu1, Y. Dai1, H. Cao2; 1Tianjin/CN, 2Beijing/CN

PURPOSE: To prospectively evaluate the impacts of ASiR reconstruction on automated volumetric measurements of pulmonary nodules with different diameters and density in a phantom using High-Definition CT (HDCT) with low dose.

METHOD AND MATERIALS:
A total of 16 pulmonary nodules with 4 diameter categories (2.5mm, 5.0mm, 10.0mm, 20.0mm) , and 5 attenuation categories (-100HU, -60HU, 0HU, 60HU, 100HU) were placed in a lung phantom . the phantom was kept beneath saline mixed with contrast material, with attenuation of the solution varying from#60HU to#70HU, scanned by HDCT under different mA (25mA, 50mA, 100mA, 200mA) , using both scan modes of HD and non-HD. 5 levels of slice ASiR reconstruction (10%, 30%, 50%, 70%, 100%) were performed accordingly to each scan. Nodule theoretical volumes was calculated by using the formulas $V = (4/3) \# r3$, Automated nodule volume measurements were performed by using Lung VCAR Single Protocol (GE, AW 4.4 workstation). Absolute percentage error (APE) was calculated to estimate the accuracy of volumetric measurement. Mixed-model analysis of variance, multivariate analysis of variance, multiple linear regression analysisand paired-samples t test were used for statistical analysis.

RESULTS:
①There were statistically significant differences in APE between 5 different steps of ASIR reconstruction respectively following HD and non-HD scan($p < 0.05$). 30% ASiR reconstruction following either HD or non-HD scan obtained the most satisfactory accuracy.②30% ASiR reconstruction following non-HD scan yielded the minimal error, there were statistically significant differences in comparison with the other 9 ASiR reconstruction using HD and non-HD scan mode ($p < 0.05$).③There was no statistically significant differences in APE among 4 different scanning tube current(p#0.05), with the 200mA tube current yielded the minimal error.

CONCLUSION
30% ASiR reconstruction following non-HD scan suits the most for nodule volumetric measurement, it maximality reduced in X-ray dose while preventing structure details, and then yielded satisfactory accuracy for pulmonary nodule volumetric measurement.

SPIE 2010

Potential benefit of the CT adaptive statistical iterative reconstruction method for pediatric cardiac diagnosis

Frédéric A. Miéville, Paul Ayestaran, Christophe Argaud, Elena Rizzo, Phalla Ou, FrancisBrunelle, François Gudinchet, François Bochud, Francis R. Verdun* Lausanne, Switzerland;

ABSTRACT: Adaptive Statistical Iterative Reconstruction (ASIR) is a new imaging reconstruction technique recently introduced by General Electric (GE). This technique, when combined with a conventional filtered back-projection (FBP) approach, is able to improve the image noise reduction. To quantify the benefits provided on the image quality and the dose reduction by the ASIR method with respect to the pure FBP one, the standard deviation (SD), the modulation transfer function (MTF), the noise power spectrum (NPS), the image uniformity and the noise homogeneity were examined.

Measurements were performed on a control quality phantom when varying the CT dose index (CTDIvol) and the reconstruction kernels. A 64-MDCT was employed and raw data were reconstructed with different percentages of ASIR on a CT console dedicated for ASIR reconstruction. Three radiologists also assessed a cardiac pediatric exam reconstructed with different ASIR percentages using the visual grading analysis (VGA) method. For the standard, soft and bone reconstruction kernels, the SD is reduced when the ASIR percentage increases up to 100% with a higher benefit for low CTDIvol. MTF medium frequencies were slightly enhanced and modifications of the NPS shape curve were observed. However for the pediatric cardiac CT exam, VGA scores indicate an upper limit of the ASIR benefit.

40% of ASIR was observed as the best trade-off between noise reduction and clinical realism of organ images. Using phantom results, 40% of ASIR corresponded to an estimated dose reduction of 30% under pediatric cardiac protocol conditions. In spite of this discrepancy between phantom and clinical results, the ASIR method is as an important option when considering the reduction of radiation dose, especially for pediatric patients.

CONCLUSION

The benefit of the ASIR method on image quality was assessed through quality control phantom images while varying the radiation dose and through a clinical exam obtained at a fixed dose. Although the noise and spatial resolution metrics were shown to have direct improvements of phantom images (for the standard, the soft and the bone kernels) up to 100% of ASIR, the VGA method applied on a pediatric cardiac exam had the best ASIR percentage to fulfill clinical criteria at around 40%. Maintaining the same diagnosis image quality, **a dose reduction of about 30% was estimated for pediatric cardiac exams** with this percentage of ASIR. In spite of this discrepancy between phantom and clinical results, the ASIR technique is an important option when considering the reduction of radiation dose, especially for pediatric patients.

SPIE 2011

Three-dimensional noise-power spectrum applied on clinical MDCT and CBCT scanners: Effects of reconstruction algorithms and reconstruction filters

Frédéric Miéville1, Mohamed Benkreira1, Gregory Bolard2, Paul Ayestaran3, François Gudinchet4, François Bochud1 and Francis R. Verdun1. University Hospital Center and University of Lausanne – 1011 Lausanne – Switzerland

Objective:
The three-dimensional (3D) noise power spectrum (NPS) is the reference metric for understanding the noise content
in CT images as well as in evaluating image quality and system performance in different reconstruction planes. To evaluate the noise properties of clinical MDCT and CBCT scanners, 2D and 3D NPSs were computed for different reconstruction parameters.

Materials and methods:
A 64-MDCT scanner and an on-board imager CBCT system were employed. Measurements were performed on a homogenous phantom at a comparable dose level for both installations. Reconstruction parameters such as the convolution kernel (soft, standard and bone) and the reconstruction algorithms (filtered-back projection (FBP), adaptive statistical iterative reconstruction (ASIR) and CBCT algorithm) were varied and images were reconstructed on different reconstruction planes (axial, sagittal and coronal). Then, 2D and 3D NPS methods were computed and NPS results were analyzed.

Results:
While the axial 2D NPS corresponding to the x-y plane of the 3D NPS was in excellent agreement with the 2D NPS computed from axial images, comparisons performed in the sagittal and coronal planes showed significant differences. These differences were associated with the interpolation method used to reformat images in the different planes. The effect of the reconstruction algorithm (FBP – ASIR) was also strongly visible on the MDCT. Comparisons of 3D NPS obtained on MDCT and CBCT installations showed that the geometry of the CT scanner modified the shape of the sagittal and coronal 2D NPSs.

Conclusion:
NPS should be systematically computed to study the noise properties of volume acquisition technique.