Conférence SPIMED - 8 juin 2012

PHILIPS

sense and simplicity

Patient radiation dose and image quality optimization in CT

Optimiser la dose patient et la qualité image en scanner

Philippe Coulon, PhD.
Philips Healthcare
CT Clinical Science
Philips DoseWise philosophy: Diagnostic IQ with minimum radiation dose

Image chain optimization

Improved management of the acquired data

Optimized practices

- Tube current modulation
  - DoseRight, Z, Angular, Cardiac DOM
- Prospective Gating
  - Step & Shoot
- Dedicated Pediatric Protocols
  - Weight and Age based kV & mAs
- Beam Filtration, Shape Compensation
  - Intellibeamt, SmartShape
- Dynamic Collimator
  - Eclipse DoseRight
- 2D Anti-scatter Collimator
  - ClearRay Collimator
- Iterative Reconstruction
  - iDose4
- Metal Artifact Correction
  - O-MAR
- Contrast enhancement
  - iBrain
- Iterative Reconstruction
  - IMR
- Adoption
  - Ease of Use - Information - Training - Evaluation
Philips DoseWise philosophy: Diagnostic IQ with minimum radiation dose

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Philips DoseWise philosophy: Diagnostic IQ with minimum radiation dose

- Tube current modulation
  - *DoseRight, Z, Angular, Cardiac DOM*

- Prospective Gating
  - Step & Shoot

- Dedicated Pediatric Protocols
  - Weight and Age based *kV & mAs*

- Beam Filtration, Shape Compensation
  - *Intellibeamt, SmartShape*

- Dynamic Collimator
  - *Eclipse DoseRight*

- 2D Anti-scatter Collimator
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- Iterative Reconstruction
  - *iDose*⁴

- Metal Artifact Correction
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Adoption
  - Ease of Use - Information - Training - Evaluation
iDose\textsuperscript{4} iterative reconstruction technique: How does it work?

**Acquisition**
- Projection space
- Image noise (carotid)

**Filtered Back Projection**
- Image space
iDose\textsuperscript{4} iterative reconstruction technique: How does it work?

**Projection space**
- **Acquisition**
  - Image noise (carotid)
- **Projections update**
  - Images update

**Image space**
- **Filtered Back Projection**
  - Images update

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**Image noise (carotid)**
- Graph showing decreasing trend in image noise.
iDose$^4$ iterative reconstruction technique: How does it work?

- **Acquisition**
- **Projections update**
- **Image noise (carotid)**

By reducing projection noise, iDose$^4$ is removing image artifacts.
iDose^4 iterative reconstruction technique: How does it work?

Acquisition

Filtered Back Projection

After projections process

Projections update

Projection space

Image space

Image noise (carotid)
iDose\textsuperscript{4} iterative reconstruction technique: How does it work?

**Acquisition**

- Projection space

**Projections update**

- Image noise (carotid)

**Filtered Back Projection**

- After projections process

- iDose\textsuperscript{4} Level 1 to 7
iDose\textsuperscript{4} main benefits

**Significant Dose Reduction with preserved Image Quality**
- Up to 80\% dose reduction depending on clinical application, initial dose and required image quality
- Same Noise Power Spectrum (NPS) and image texture than full dose

**Image Quality improvement**
- Artifacts reduction
- Contrast to Noise Ratio (CNR) improvement
- Spatial Resolution improvement

**Fast and Easy**
- Preserved reconstruction speed (up to 20ips)
- Same workflow for routine practice
- Flexible (7 iDose\textsuperscript{4} levels)
First iDose⁴ experience at Hôpital Privé d'Antony, France (iCT & Br64)

Run Off (different patient with same size) 2123 mGy.cm, FBP / 257 mGy.cm, iDose

<table>
<thead>
<tr>
<th>Date</th>
<th>Dose / % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 25, 2011</td>
<td>8.3 (-88%)</td>
</tr>
<tr>
<td>June 30, 2011</td>
<td>2123 mGy.cm, FBP / 257 mGy.cm, iDose</td>
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Chest follow up 453 mGy.cm, FBP / 130 mGy.cm, iDose

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<tr>
<th>Date</th>
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<td>March 25, 2011</td>
<td>3.5 (-71%)</td>
</tr>
<tr>
<td>July 20, 2011</td>
<td>453 mGy.cm, FBP / 130 mGy.cm, iDose</td>
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Run Off (different patient with same size)
First iDose⁴ experience at Hôpital Privé d'Antony, France (iCT & Br64)

Run Off (different patient with same size)
2123 mGy.cm, FBP / 257 mGy.cm, iDose

Dose / 8.3 (-88%)

Chest follow up
453 mGy.cm, FBP / 130 mGy.cm, iDose

Dose / 3.5 (-71%)

March 25, 2011

July 20, 2011

Major dose reduction

for High Contrast applications (lung, CTA):
Up to more than 80% depending on clinical indication, initial dose and required image quality.

May 25, 2011

June 30, 2011
First iDose\(^4\) experience at Hôpital Privé d'Antony, France (iCT & Br64)

C/A/P oncology follow up
1136 mGy.cm, FBP /
June 23, 2011

C/A/P oncology follow up
911 mGy.cm, FBP /
April 7, 2011

Courtesy Hôpital Privé d'Antony, France
First iDose⁴ experience at Hôpital Privé d'Antony, France (iCT & Br64)

C/A/P oncology follow up
1136 mGy.cm, FBP / 555 mGy.cm, iDose
June 23, 2011

Dose / 2 (-50%)
July 21, 2011

C/A/P oncology follow up
911 mGy.cm, FBP / 502 mGy.cm, iDose
April 7, 2011

Dose / 1.8 (-45%)
July 1, 2011

Courtesy Hôpital Privé d'Antony, France
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**iDose⁴ for brain**

**Brain CT**
- 120 kV, 500 mAS, FBP / 350 mAs, iDose

**Dose / 1.4 (-30%)**
- 120 kV, 500 mAS, FBP / 350 mAs, iDose

**Brain CT**
- 120 kV, 300 mAS, FBP / 250 mAs, iDose

**Dose / 1.2 (-17%)**
### iDose⁴ for brain

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<tr>
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*Lower but still significant dose reduction for Low Contrast applications:*

Typical 30-60% for Abdomen and 15-30% for Brain.

And still depending on clinical indication, initial dose and required image quality.
Dose reduction in routine practice with iDose

Dose reports to IRSN for Diagnostic Reference Levels.
Same site, same team.

Brain

-15%

Brilliance 64 without iDose

Ingenuity CT with iDose

Courtesy Polyclinique Poitiers, France
Dose reduction in routine practice with iDose⁴

Dose reports to IRSN for Diagnostic Reference Levels.
Same site, same team.

Brilliance 64 without iDose⁴

Ingenuity CT with iDose⁴

-55%

C-A-P

Courtesy Polyclinique Poitiers, France
Ultra low dose with iDose$^4$

Chest X-ray

$\sim 0.05 \text{ mSv}$

1.50m, 68 kg - BMI=30

120 kVp, 100 mAs
DLP= 188 mGy.cm  **2.6 mSv**

80 kVp, 10 mAs
DLP= 5.8 mGy.cm  **0.08 mSv**

FBP

iDose$^4$ Level 7

Courtesy: UCL, Brussels
Ultra low dose with iDose⁴

Chest X-ray
~ 0.05 mSv

1.50m, 68 kg - BMI=30

Ultra-low dose MDCT + iDose⁴
0.08 mSv

80 kVp, 10 mAs
DLP = 5.8 mGy.cm

Courtesy: UCL, Brussels
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Improved management of the acquired data

Image chain optimization

Adoption
- Ease of Use - Information - Training - Evaluation
Improved visualization
In the presence of metal orthopedic implants
Metal Artifact Correction: O-MAR

Improved visualization
In the presence of metal orthopedic implants

With O-MAR
Metal Artifact Correction: O-MAR

Improved visualization
In the presence of metal orthopedic implants

FBP without O-MAR  FBP with O-MAR  iDose$^4$ with O-MAR

Courtesy Hospital of Special Surgery, USA
Metal Artifact Correction: O-MAR

Improved visualization
In the presence of metal orthopedic implants

FBP without O-MAR

iDose$^4$ with O-MAR

Courtesy of Az Ospedaliera University
Philips DoseWise philosophy: Diagnostic IQ with minimum radiation dose

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Improved management of the acquired data
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Image chain optimization

Improved management of the acquired data

Optimized practices
Improved management of dose parameters with v4.0

With Ingenuity CT 4.0

Scan Parameters

- Dose Right Index: 15
- KV: 120
- mAs: 60
- Scan Time: 9.1 sec

CTDI: 10.4 mGy
DLP: 631 mGy*cm
Phantom: 32 cm

Show All...
Improved management of dose parameters with v4.0
Improved management of dose parameters with v4.0

Patient B
2 M/42Y
100-1
767.0 mm

Scan Parameters

Dose Right Index 15
KV: 120
mAs: 60 - 255
Scan Time: 9.1 sec
CTDI: 10.4 mGy
DLP: 631 mGy*cm
Phantom: 32 cm

43% dose reduction

Liver Boost
Standard DOM
Philips DoseWise philosophy: Diagnostic IQ with minimum radiation dose

Image chain optimization
From global to individual optimization:
- Dose adapted to patient
- Image Quality adapted to clinical need

Improved management of the acquired data
Diagnostic Image Quality with Low Dose:
- Significant dose reduction
- Improved Image Quality
- Artifacts reduction

Optimized practices
Master your CT:
- Ease of use / Training
- Dose reporting / Dose control

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