

Prospective vs. Retrospective CTA

A quick look at patient dose and image quality

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Introduction

- Hospital A has been carrying out CT Angiograms for > 12 months on a Siemens Definition AS+ scanner
- Hospital B has been carrying out CTAs for < 6 months on a Siemens Definition AS+ scanner
- The aim of this study was to assess patient doses for both prospective and retrospective CTAs at both hospitals, with a view to optimise protocols
- Image quality was briefly assessed at Hospital B (where we had access to PACS)

Method

- Patient protocol data was collected from each scanner
- DLP, $CTDI_{vol}$, pitch, kV, and rotation time were collected
- No patient specific data (height/weight/heart rate) was collected
- Mean CT number and standard deviation were measured in the contrasted artery of CTA images at hospital B to calculate the signal to noise ratio (SNR)
- Effective dose (D_{eff}) and breast equivalent dose (BED) were calculated using the ImPACT CT Dose calculator v1.0 which includes the ICRP 103 tissue weighting factors

Data collected

- Hospital A: 28 retrospective CTAs
- Hospital B: 14 retrospective and 17 prospective CTAs

Protocol information:

- 100 – 120 kV
- Rotation time 0.23 – 0.5 s
- Pitch 0.18 – 0.30
- $CTDI_{vol}$ 4.85 – 42.32 mGy
- DLP 50 – 642 mGy.cm

Hospital A

Retrospective CTA

Median

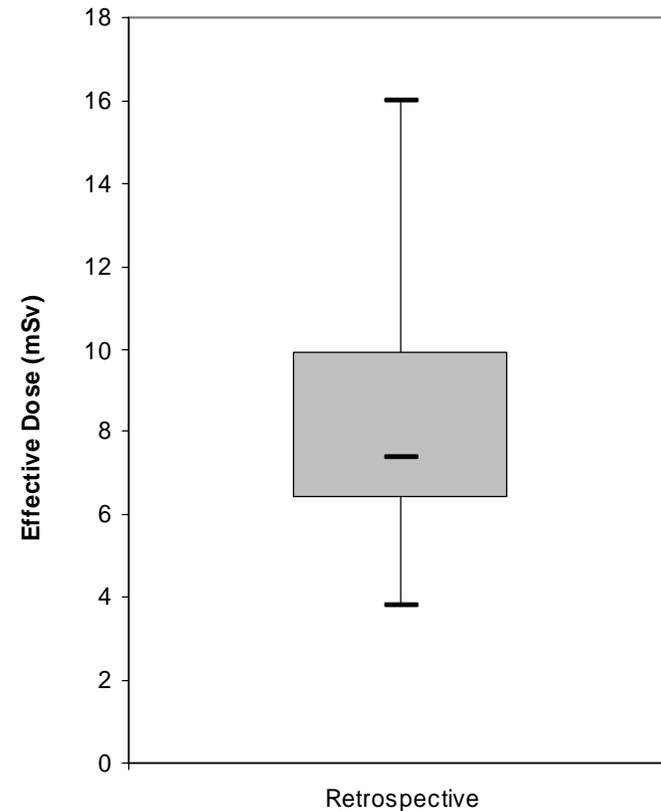
- DLP = 274 mGy.cm
- Deff = 7.4 mSv
- BED = 24 mGy

75th percentile (DRL)

- DLP = 372 mGy.cm
- Deff = 9.9 mSv
- BED = 32 mGy

No access to PACS for IQ analysis

Multiplication factor = $27 \mu\text{Gy}(\text{mGy.cm})^{-1}$



Hospital B

Retrospective CTA

Median

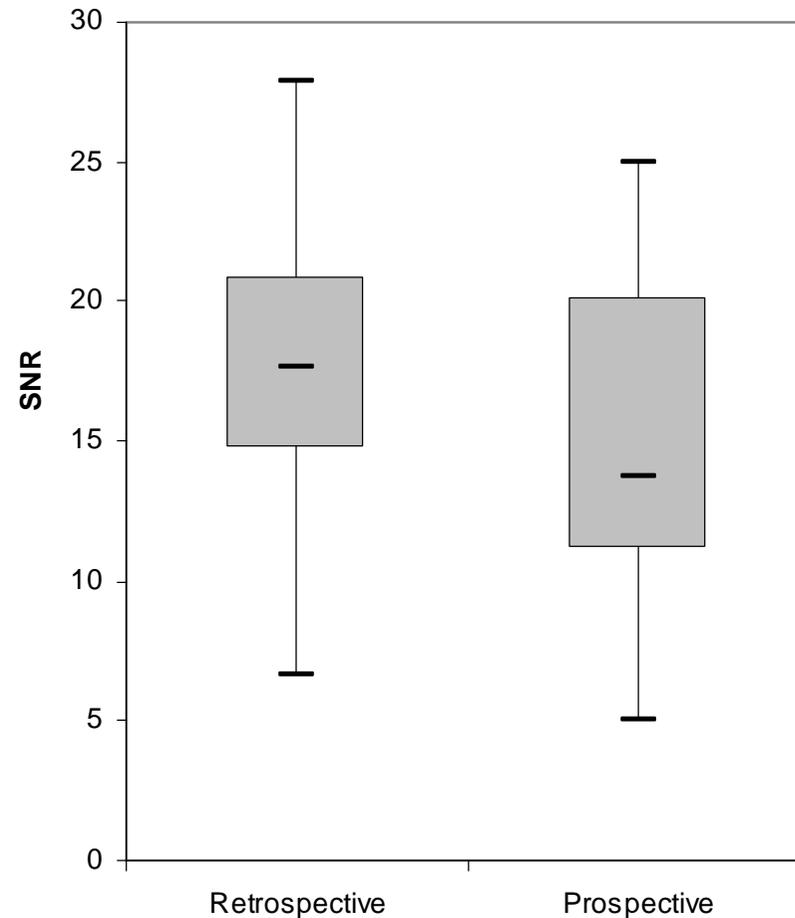
- DLP = 263 mGy.cm
- Deff = 7.25 mSv
- BED = 23 mGy
- SNR = 17.6

Prospective CTA

Median

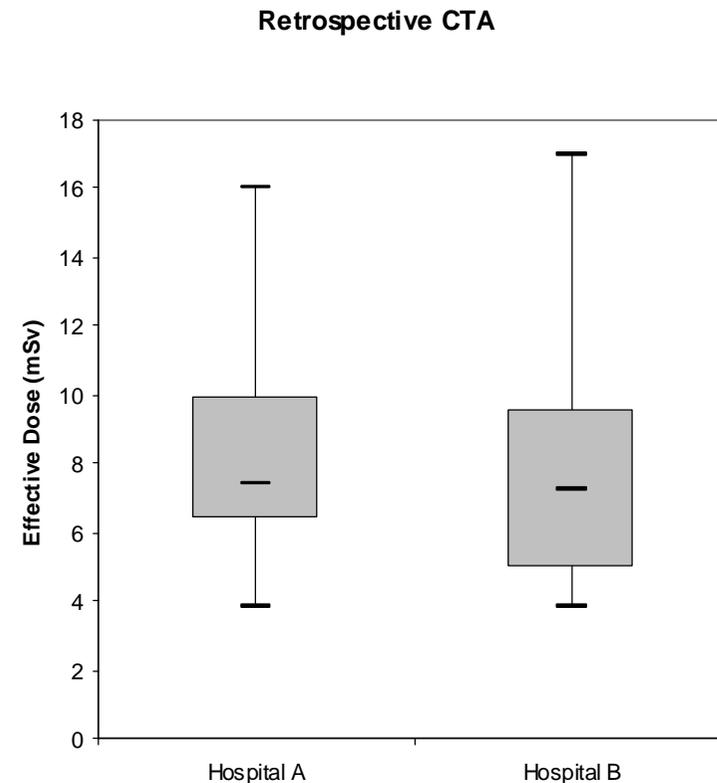
- DLP = 137 mGy.cm
- Deff = 3.45 mSv
- BED = 11 mGy
- SNR = 14.1

Multiplication factor = $27 \mu\text{Gy}(\text{mGy.cm})^{-1}$



Hospital Comparison

- Median and third quartile doses for retrospective CTA are equivalent at both hospitals
- Both dose distributions are skewed, with maximum doses far greater than the median
- Maximum doses of 16-17 mSv are too high and must be investigated further



Literature Review

CTA Doses

- Hausleiter *et al* (2009): Median effective dose 9 mSv for prospective CTA on Siemens 64 slice scanner
- Huda *et al* (2010): Calculated a factor of $26.2 \mu\text{Sv}(\text{mGy}\cdot\text{cm})^{-1}$ for CTA on Siemens Definition AS+

CTA Dose and IQ

- Feng *et al* (2010)
 - Study of effective doses, SNR and CNR for prospective and retrospective CTA
 - Mean effective dose 2.7 mSv for prospective CTA on Siemens Definition AS
 - Found significant difference between effective doses
 - Found no significant difference in SNR
 - Found an increase in CNR for prospective CTA

Literature Comparison

- Doses for prospective and retrospective CTA consistent with literature (below)
- Multiplication factor is consistent with Huda *et al* (2010)
- No significant difference in SNR, consistent with Feng *et al* (2010)

Site/Study	Mean Effective Doses (mSv)	
	Prospective	Retrospective
Hospital A	-	8.3 ± 3.1
Hausleiter <i>et al</i> (2009)	-	*9 (7-14)
Hospital B	3.2 ± 1.3	7.9 ± 3.8
Feng <i>et al</i> (2010)	2.71 ± 0.67	-

*Median (interquartile range)



Conclusions

Hospital A

- doing mainly retrospective CTA and therefore doses are high
- should encourage them to do more prospective if possible

Hospital B

- doing 50:50 prospective and retrospective CTA
- doses for prospective are around 50% less
- no significant difference in average SNR despite drop in dose
- a few retro and prospective studies had very poor SNR (~5)

Conclusions

- Breast doses are high but cannot use Bi filter since CAREDOSE works real-time and would increase mA accordingly
- Effective doses are comparable with literature and are generally low compared with other manufacturers
- However further work is required to investigate the cases with very high dose and the cases with very poor SNR
- Once more data is available for Hospital B we would like to extend the study and include patient data to optimise protocols
- CNR could also be measured as a further measure of IQ

Optimisation methods

- Use prospective gating where possible
- Reduce kV for smaller patients
 - 100kV<85kg gives 39% D_{eff} reduction for same IQ [Pfleiderer *et al* (2009)]
- Increase kV for larger patients?
- Optimise mA/ modify level of CAREDOSE
- Reduce number of phases
- Check pitch

References

- Feng *et al* 2010 Prospective ECG triggering versus low-dose retrospective ECG-gated 128-channel CT coronary angiography: comparison of image quality and radiation dose *Clin Radiol.* **65(10)** 809-14
- Hausleiter *et al* 2009 Estimated Radiation Dose Associated With Cardiac CT Angiography *JAMA.* **301(5)** 500-507
- Huda *et al* 2009 Computing effective dose in cardiac CT *Phys. Med. Biol.* **55** 3675–3684
- Pflederer *et al* 2009 Image Quality in a Low Radiation Exposure Protocol for Retrospectively ECG-Gated Coronary CT Angiography *AJR* **192** 1045-1050