Ask EuroSafe Imaging

Tips & Tricks

CT Working Group

Optimization of scan length to reduce CT radiation dose

Alban Gervaise (Centre Hospitalier Universitaire Nancy, FR)
Mika Kortesniemi (HUS Medical Imaging Center, University of Helsinki, FI)
Dean Pekarovic (University Hospital Ljubljana, SI)

Key points

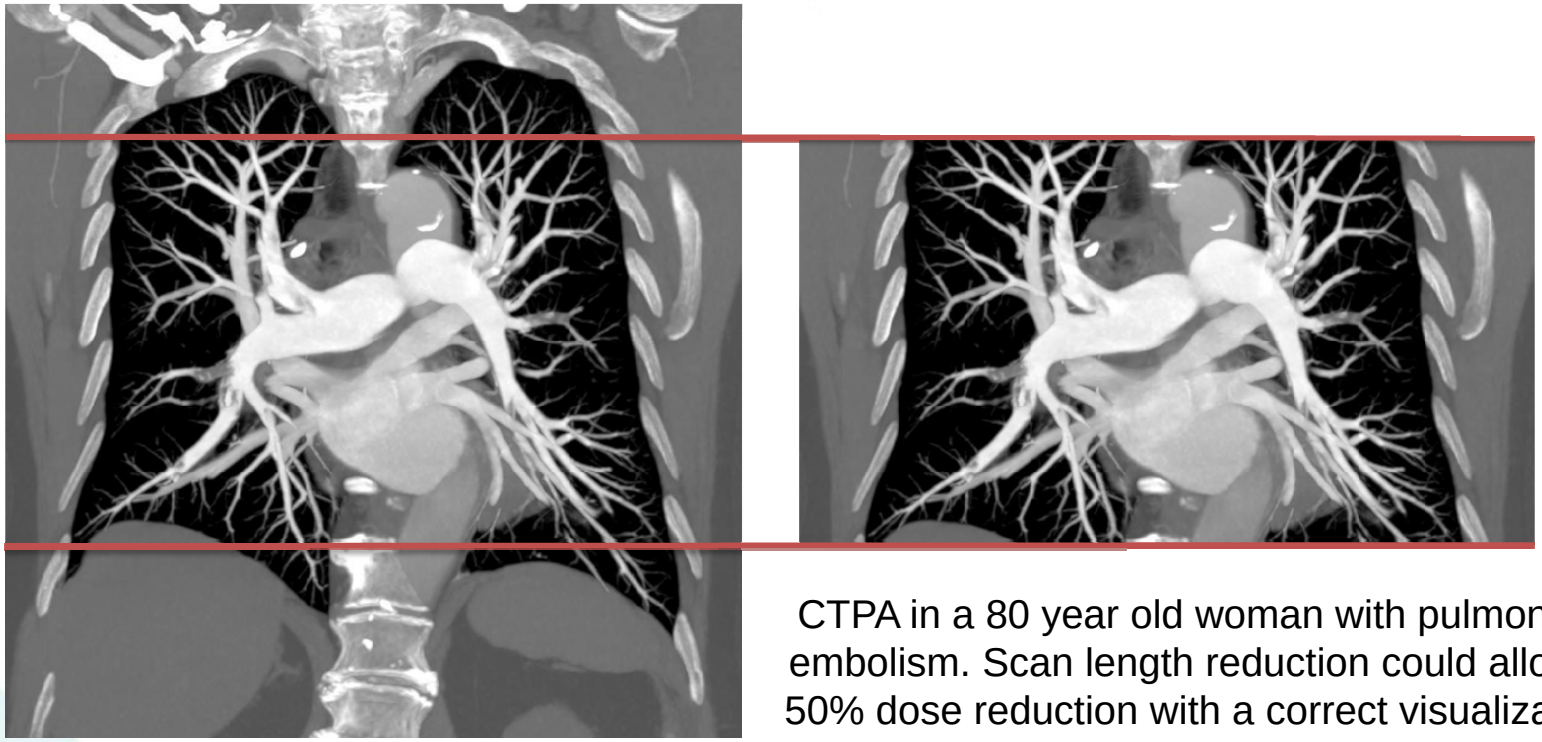
- Scan length defines the exposed region of the patient.
- Scan length is directly related to CT radiation dose.
- A shorter scan length means lower dose if all other scan parameters and the anatomical region are held constant: «The smaller the exposed area, the smaller the dose».
- With rapid scanning capabilities of modern MDCT, tendency to extend beyond the desired target region of interest must be avoided.
- Optimization of CT scan length is an easy and simple way to reduce CT radiation dose. Specific dose effect depends on the patient attenuation – how many sensitive organs are included in the scan range and it's vicinity (including dose from scattered radiation).
- Scan length should be adapted strictly to the clinical indication for each individual patient and must be limited to the zone of interest, previously identified by the scout views.
- Reduction of z-axis coverage can be performed e.g. for renal colic CT and CTPA for pulmonary embolism.

$CTDI_{vol}$ and DLP

- $CTDI_{vol}$ (volume CT dose index; mGy) is a standardized parameter to measure scanner radiation output. It basically describes the average dose within the scan range taking into account the scattered radiation.
- DLP (dose length product; mGycm) is the product of the length of the irradiated scan volume and the average $CTDI_{vol}$ over that distance.
- Both values are calculated by scanner and standardized cylindrical phantom (∅ 16 cm for head phantom and ∅ 32 cm for body phantom) and as such, they do not mean patient dose.
- $CTDI_{vol}$ and DLP are displayed in each CT console and can be easily monitored.
- DLP can be reduced by reducing the scan length.

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm	TI s	cSL mm
Patient Position H-SP							
Topogram	1	120	36 mA	0.14 L	3	2.7	0.6
GLAVA spi nat	2	120	380	54.71 S	394	1.0	0.6
GLAVA spi nat	3	120	380	54.71 S	449	1.0	0.6
GLAVA spi nat	4	120	380	54.71 S	722	1.0	0.6

Reducing the scan coverage of CTPA performed for pulmonary embolism above the aortic arch and below the base of the heart can reduce CT dose by 70 % without impairing PE diagnosis.



CTPA in a 80 year old woman with pulmonary embolism. Scan length reduction could allow a 50% dose reduction with a correct visualization of the blood clots.

Shakir K. *et al.* Emerg Radiol. 2O15

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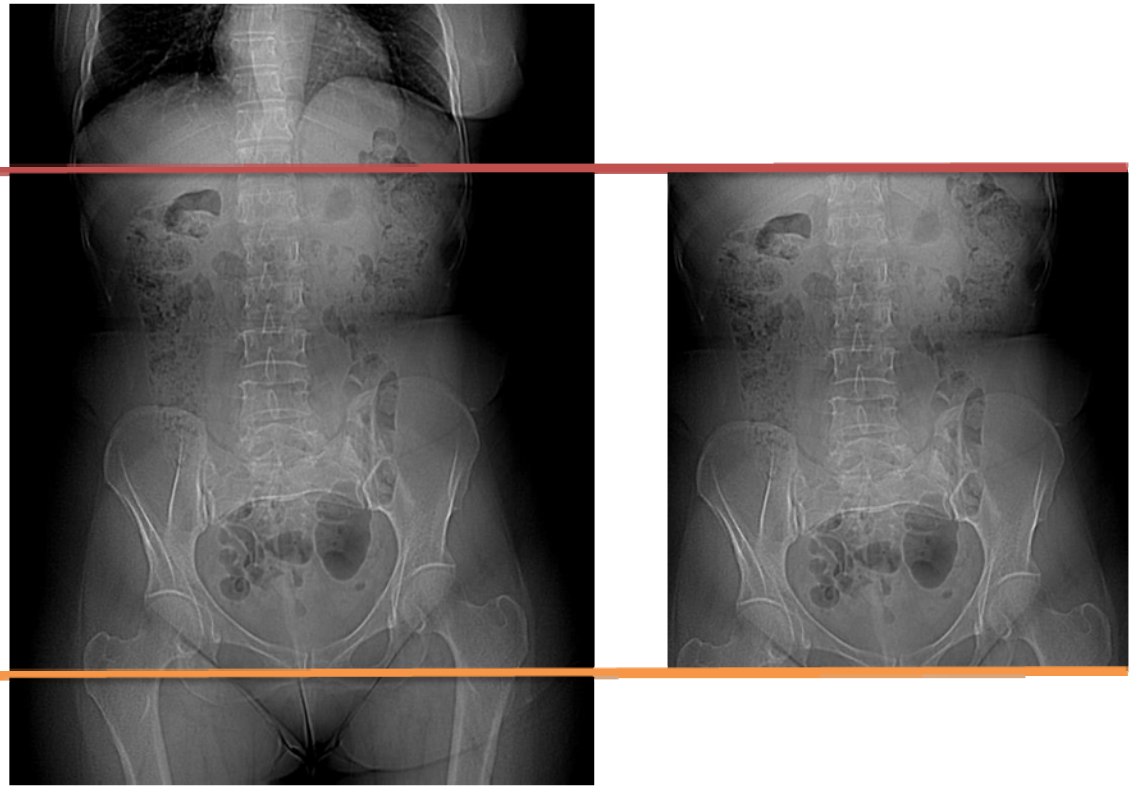
For renal colic CT, the scan coverage should be centred from the top of the kidneys to the lower edge of the bladder.

For the upper acquisition limit, the inferior margin of the 10th thoracic vertebral body (T10) can be used in the frontal scout



For the lower acquisition limit, the middle of the symphysis pubis bone is an accurate landmark.

Centring the acquisition for renal colic CT allows a dose reduction of 15-20%.

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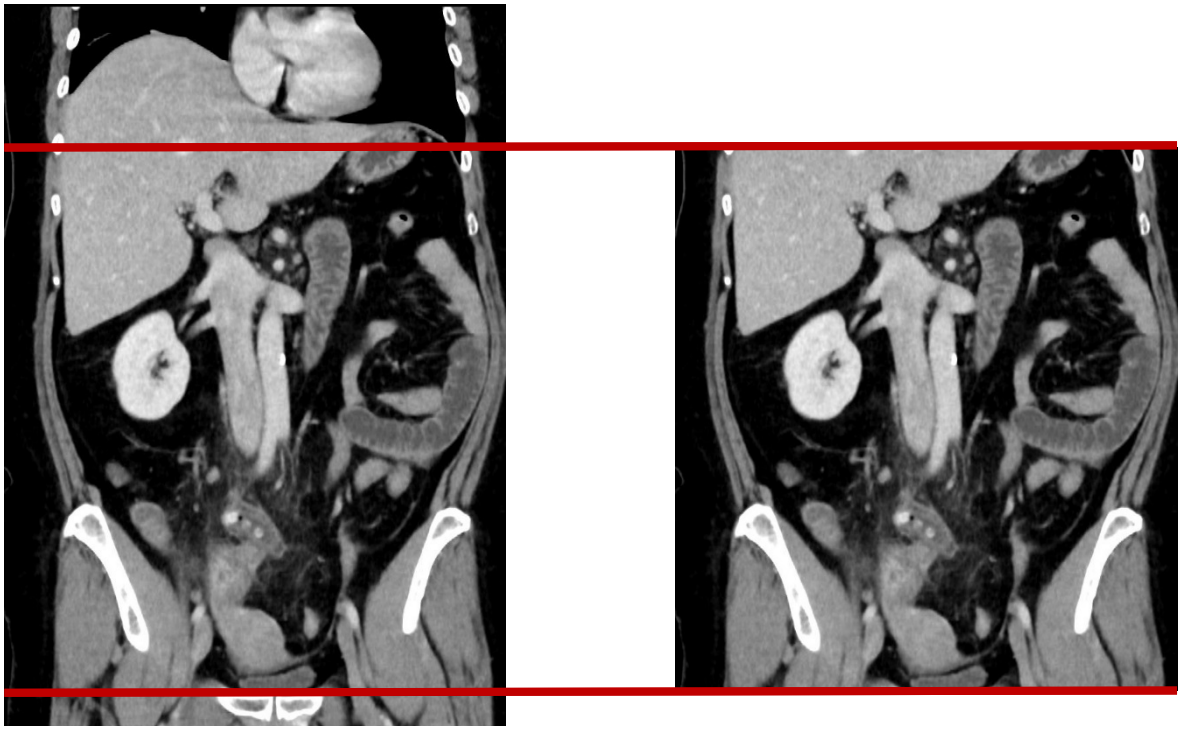
Corwin MT *et al.* JCAT 2014

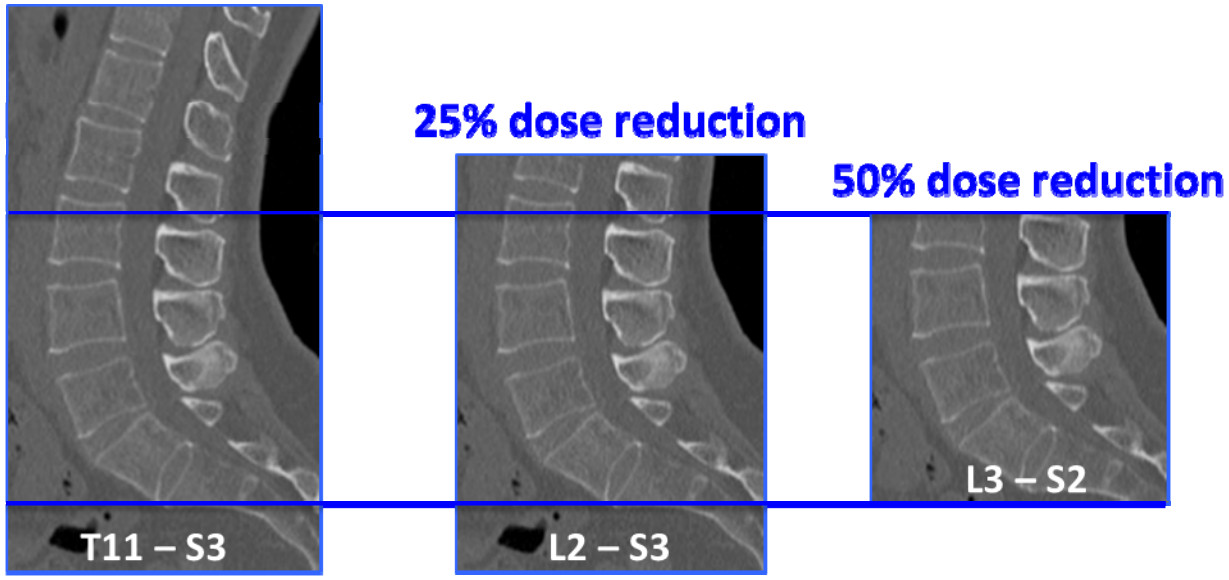
For appendicitis, the scan length can be reduced from the inferior margin of T10 and the superior border of pubic symphysis.



Appendicitis in a 57 year old woman. Scan length reduction could allow a 25% dose reduction without impairing the diagnosis of appendicitis.

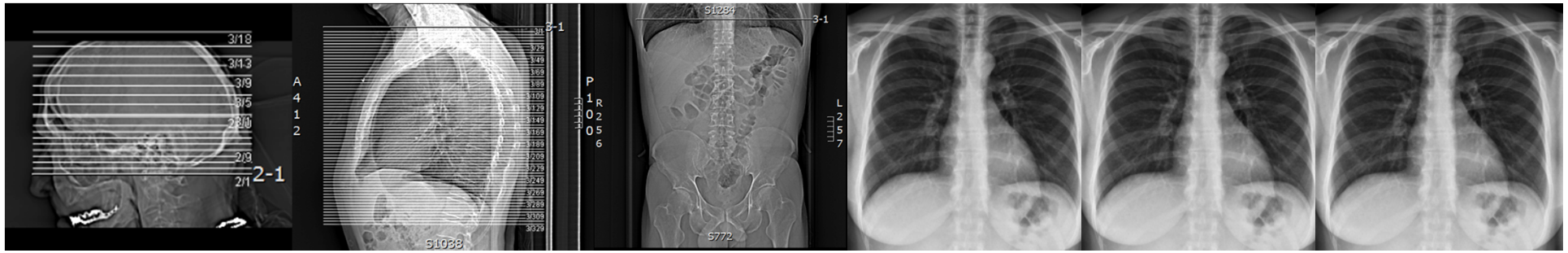
Corwin MT et al. Abdom Imaging 2015

For lumbar spine CT, acquisition limit must be adapted to the clinical symptomatology.



Example of a lumbar spine CT performed for L5-S1 radiculopathy. The CT-scan covered T11 to S3. A centring of the acquisition to L3-S2 allows to reduce CT dose by half.

One Finger More



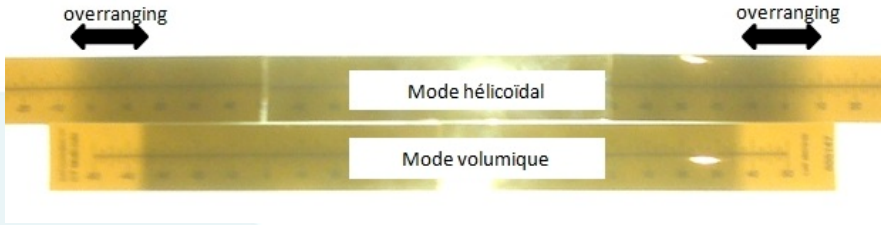
From Hospital CT Protocols **(Adult)**				
Body region	CTDI (mGy)	DLP ($mSv\ mGy^{-1}cm^{-1}$)	+2,5 cm (mSv)	Chest x-rays
Head	60	0.0021	+0.32	+3
Thorax	12	0.014	+0.42	+4
Abdomen	15	0.015	+0.56	+6

A simple example how to express the effect of one finger more (2,5 cm) of scan length in extra effective dose and number of chest x rays.

- DKVRT, UMC LJ
- Deak et al. Radiology 2010

Over-ranging: Implications on scan parameter choice

- **Over-ranging means an extra longitudinal exposure in the beginning and end of the scan range in helical CT acquisition in order to assure an adequate set of raw data for CT image reconstruction.**
- **For short scan length:** over-ranging can represent a significant portion of overall dose.
  - Thus, short scan ranges should be scanned at lower pitch and lower beam collimation or with volumic mode on wide-area detector CT.
    - Ex: Small joints, small regions of interest, head CT
- **For longer scan length:** over-ranging represents a small portion of overall dose.
  - Thus, long scan ranges can be scanned with faster pitch and wider beam collimation to decrease scan times (e.g. Chest CT, Abdomen CT, extremity CT).
- **Over-ranging can be mostly avoided with new scanner models with dynamic z-collimation.**



Example of a volumic mode acquisition of 16 cm with a 320-MDCT and a helical mode acquisition with a 64-MDCT. Note the additional dose exposure with helical mode due to over-ranging at the beginning and at the end of the scan if dynamic collimation is not available.

- IAEA, CT Dose Management
- Gervaise A et al. RSNA 2012

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- https://rpop.iaea.org/RPOP/RPoP/Content/News/10-e-learning.htm