Cutting down radiation in CT scans : How we did it on CT urography

Sungwon Lee, Seung Eun Jung, Department of Radiology

Purpose

- **To assess the effect on image quality and radiation dose of CT urography with a lower photon energy protocol (100-kVp) in adults.**
- **To assess the effect of clinician-oriented lectures focusing on the radiation dose of CT urography.**

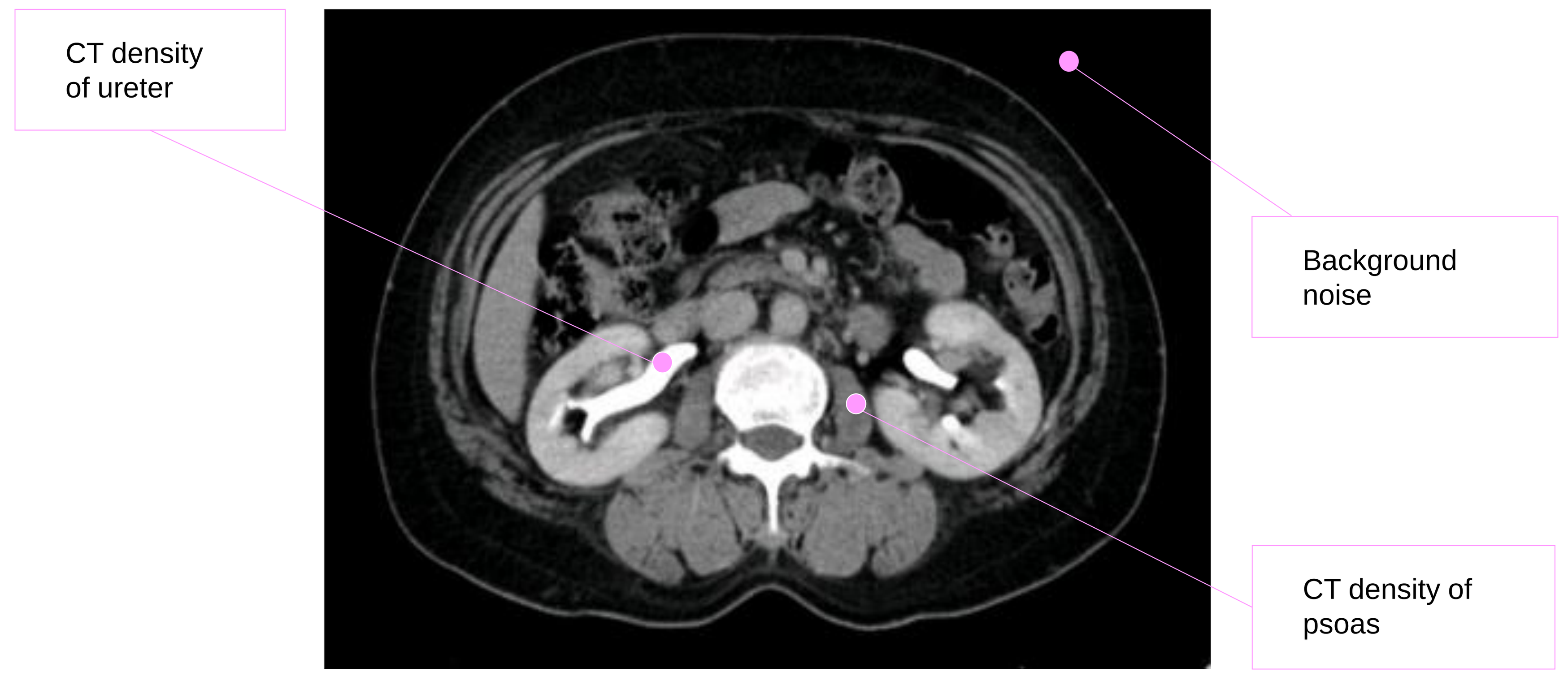
Backround

- **CT urography is a multiphasic CT scanning technique, which includes images of the urinary tract filled with contrast medium.**
- **Most of the candidated of CT urography are relatively young and experience repeated examination throughout there lifes due to recurrent attacks.**
- **In general, with lower kVP, the radiation dose reduces and the image quality mostly deteriorates.**
- **Iodine, bone and calcification are known to show increased HU value in lower kVP.**

Strategy 1 : Reducing the kVP

Materials and methods

- ***60 patients undergoing CT urography for hematuria were randomly classified into group A (100kVP) and group B (120kVP).***
- ***The image quality and radiation dose of both groups were compared.***
- ***CT urography technique at Seoul St Mary's hospital***
  - Definition AS+ (Siemens Medical System)
  - Section collimation, 0.6mm, Pitch 0.7, gantry rotation 0.5sec
  - Precontrast phase ; from the kidney upper pole to the pelvis
  - Nephrographic phase; Bolus tracking, 120HU Threshold, 50 sec delay
  - Urographic phase; Kidney upper 10 min delay, prone position
  - Image reconstruction
  - Axial image 5mm section thickness all phases
  - Coronal image 5mm section thickness in Nephrographic and Urographic phases
  - MIP, volume rendering with/without bone in Urographic phase
- ***Image quality parameters***
  - Subjective: The CT scans were classified by two radiologists with a scoring rate of 5 (Excellent, good, moderate, still diagnostic and nondiagnostic).
  - Quantitative: The signal intensity(CT number) of the ureter, the psoas muscle and background air was measured and the Signal to noise ratio (SNR) and Contrast to noise ratio (CNR) of the ureters were calculated.
- ***Radiation dose parameters***
  - Automatic display in console
  - Volume CT dose index (CTDIvol) & Dose length product (DLP) in all phases, Total DLP & effective dose (ED)
  - (conversion factor, 0.015)



SNR of the ureter = CTD_u /BN
CNR of the ureter = (CTD_u – CTD_p)/BN
CTD_u :CT density of ureter
CTD_p : CT density of the psoas muscle
BN: Background noise

Results

- There was no significant difference in SNR, CNR and subjective image quality between the 100kVP and 120kVp protocols.
  - The 100 kVp protocol had a significantly higher mean attenuation of urinary tract than 120 kVp protocol and also a higher image noise.
- Mean CTDIvol and DLP of nonenhanced scan and urographic phase for 100 kVp protocol were significantly lower and nearly halved, compared with 120-kVp protocol, which resulted in significantly lower effective dose for 100 kVp protocol.

Parameter		Group A (100kVp)		Group B (120kVp)	P value
Noise	Ureter	1022.1 ±423.9	>	743.7 ±381.2	0.030
	Psoas m.	63.9 ±5.8		59.9 ±6.4	0.014
	BN	7.8 ±0.7		6.3 ±0.9	0.000
Quantitative image quality	SNR	132.0 ±52.3	=	119.6 ±51.4	0.358
	CNR	123.7 ±51.9		109.7 ±51.3	0.303
Subjective image quality	Subjective score	4.2 ±0.8	=	4.0 ±0.8	0.800
Radiation dose	CTDIvol (mGy) u	5.2 ±0.9	<	9.1 ±1.3	0.000
	DLP (mGyxcm) u	230.7 ±46.5		409.9 ±68.3	0.000
	Total DLP (mGyxcm)	949.4 ± 220.5		1289.5±216.2	0.000
	ED (mSv)	13.9 ± 3.3		19.3 ±3.3	0.000

BN (Backround noise), SNR (Signal to noise ratio of the ureter), CNR (Contrast to noise ratio of the ureter), CTDIvol (Volume CT dose index), DLP (Dose length product), ED (Effective dose)

►**Thus with the 100kVP protocol, we can reduce the estimated effective dose by 27.98% (over 50% in just the single urographic phase) without causing significant difference in quantitative and subjective image quality**

Strategy 2 : Clinician-oriented lectures

Materials and Methods

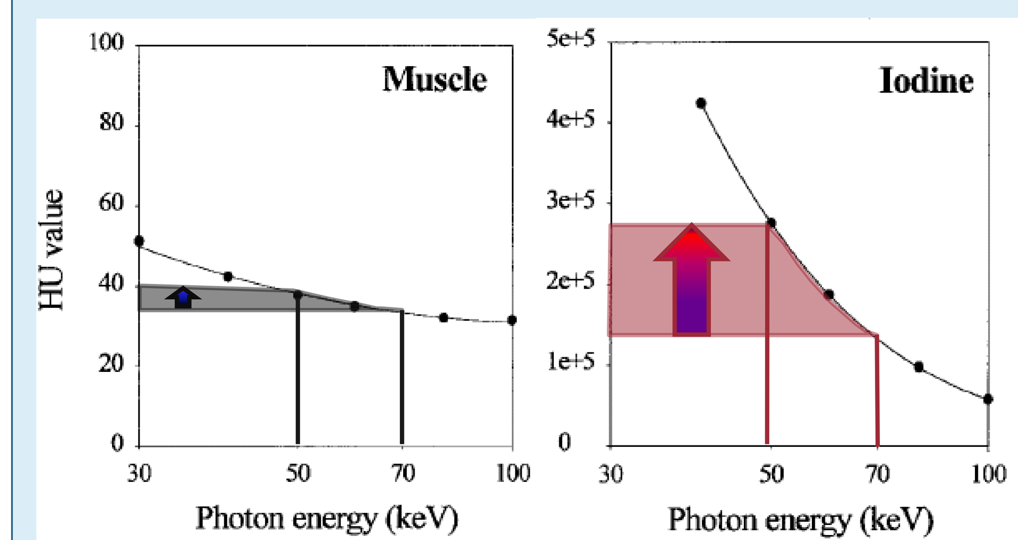
- We arranged lectures targeted for Urologists and Nephrologists at our institution.
- The lectures mainly focused on the radiation dose of CT urography, it's alternatives and why justification is needed.
- We analysed the number of prescribed CT urography before and after the lecture.

Results

The average number of CT urography prescribed per month decreased 44.2% after the clinician-oriented lectures, especially under 30 years old.

Discussion

- ***The reason why lowering the kVP did not affect the image quality is…***
  :With low kVP, there is somewhat increase in background image noise that may effect the image quality of the muscle, bone and fat but this is less concerning for the structures filled with iodine because the increase in iodine attenuation is much more greater that the soft tissues and may compensate for the increased background image noise effect.



◄ **When the photon energy is decreased, there is a greater increase of the density in iodine than muscle. As the ureter is filled with iodine, the density of the ureter elevates more than the surrounding backround density, making the SNR and CNR of the ureter at the lower photon energy similar to the higher energy.**

- ***The limitation of the study may be…***
  - Must consider other factors that influence the iodine delivery, such as circulatory status of the patient or disease-related changes
  - 100kVP protocol cannot be extended to the accurate diagnosis of soft tissue disease of the abdominal organ.

- We are currently practicing the 100kVP protocol in all CT urography at our hospital and study of 80kVP protocol is in progress.
- We are also planning to continue the annual lectures and expand the target to radiologists, technicians and clinicians.

Reference

- Coppenrath E et al. Dose reduction in multidetector CT of the urinary tract. Studies in a phantom model. Eur Radiol 2006;16:1982-9
- Kalender W/A et al. Technical approaches to the optimisation of CT. Phys Med. 2008;24(2);71-9