Demonstration of an Effective Ultra Low Dose CT Protocol with Lower Radiation Dose than Abdominal X-Ray

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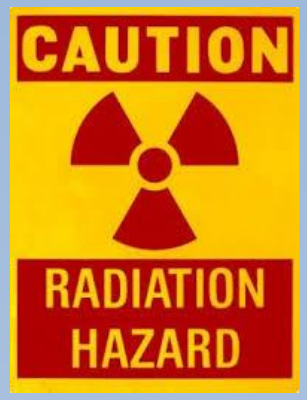
I have no conflict of interest to disclose

How do we identify calculi?

The problem:

- Need for effective imaging
- Need to minimize radiation exposure



The traditional modality options:

- Non contrast CT A/P
- Low dose CT (CT-KUB)
- KUB abdominal X-ray

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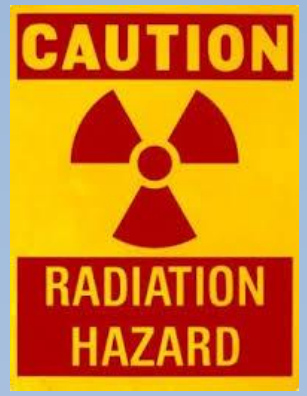


Novel modality:

Ultra low dose CT (ULDCT)

How does ULDCT compare to KUB?

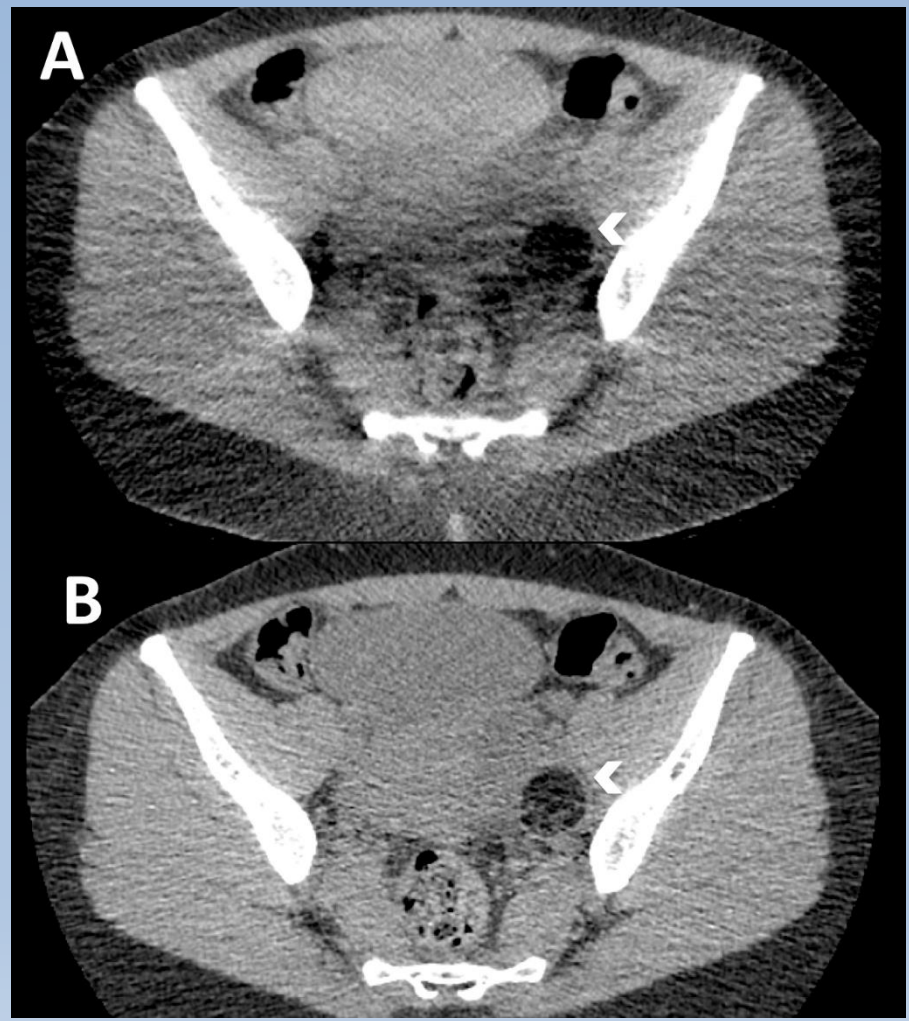
Issues of concern:

Quality degraded CT examination

Negative predictive value of CT is reduced

Hypothesis: ULDCT superior to KUB at:

- Detecting symptomatic calculi
- Lower radiation exposure



Insights Imaging. 2014 Apr;5(2):217-30

83 patients included in study

Methods:

- Prospectively recruited **104** patients

- Pre-procedure
  - Abdominal Radiograph
  - Ultralow dose CT (ULDCT)

- Exclusions
  1. BMI >30
  2. Conventional Dose CT <100 days

Patient demographics

- 83 patients included in study

- Prevalence of calculi
  - **100%**

- **41** Ureteric Calculi
  - 14 with hydronephrosis
  - Size **7.7**±3.6mm

- **234** Renal Calculi
  - Majority measuring less than **2mm**

Identification of calculi is superior in ULDCT

KUB

ULDCT

CT

0.54±0.11 mSv

0.28±0.08 mSv

6.06±3.08 mSv

KUB abdominal radiograph

True Positive 33	False Positive 3
False Negative 8	True Negative 39

6 measuring >5mm

Diagnostic Performance

PPV= 83%

NPV= 92%

Sensitivity = 80%

Specificity= 93%

ULDCT 48% lower radiation dose than KUB

KUB 0.64mSv

ULDCT 0.31mSv

CT 9.3mSv

Ultra Low Dose CT

True Positive	False Positive
39	1
False Negative	True Negative
2	41

Both measure <2mm

<u>Diagnostic Performance</u>

PPV = 98%

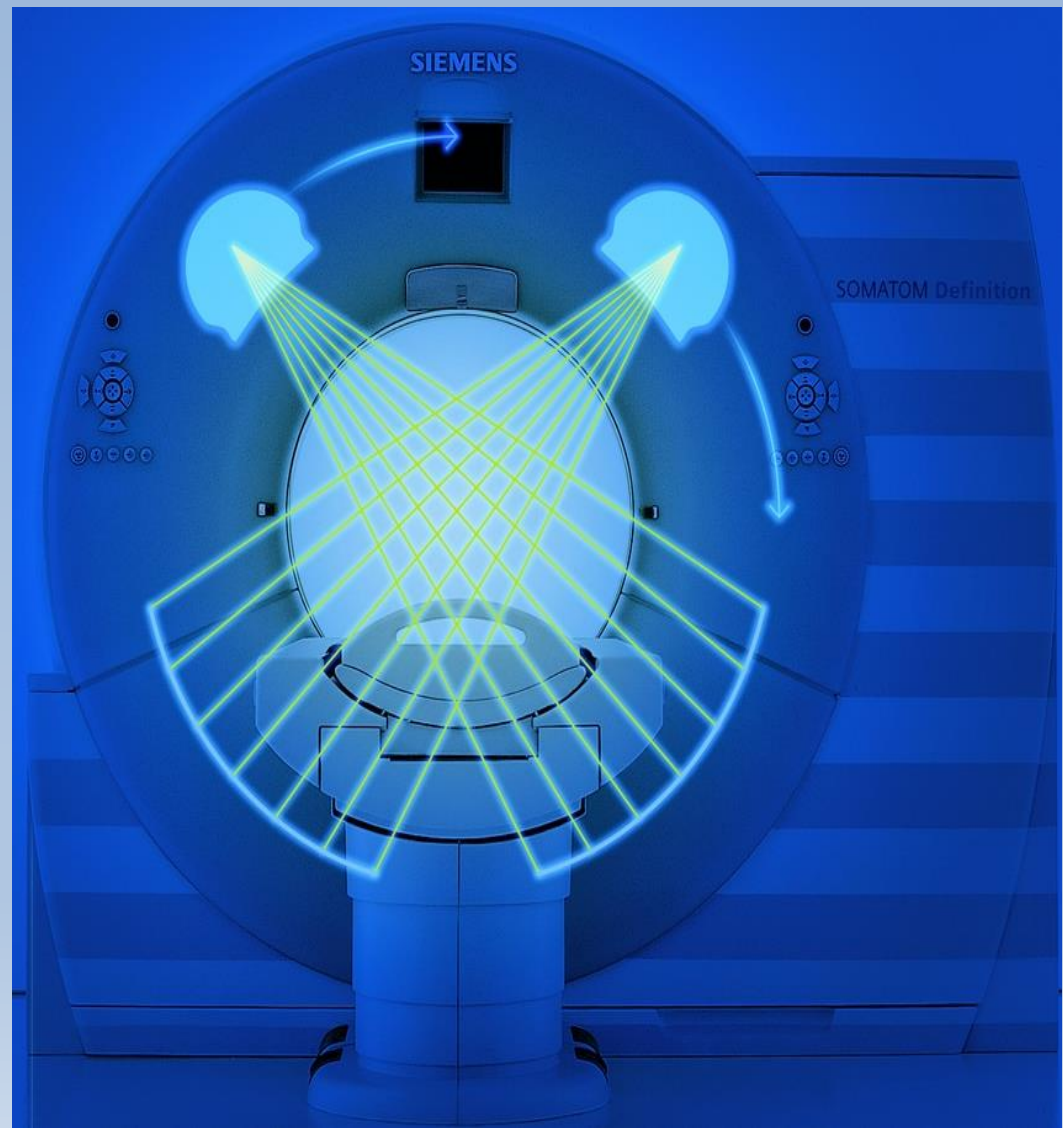
NPV = 95%

Sensitivity = 95%

Specificity = 98%

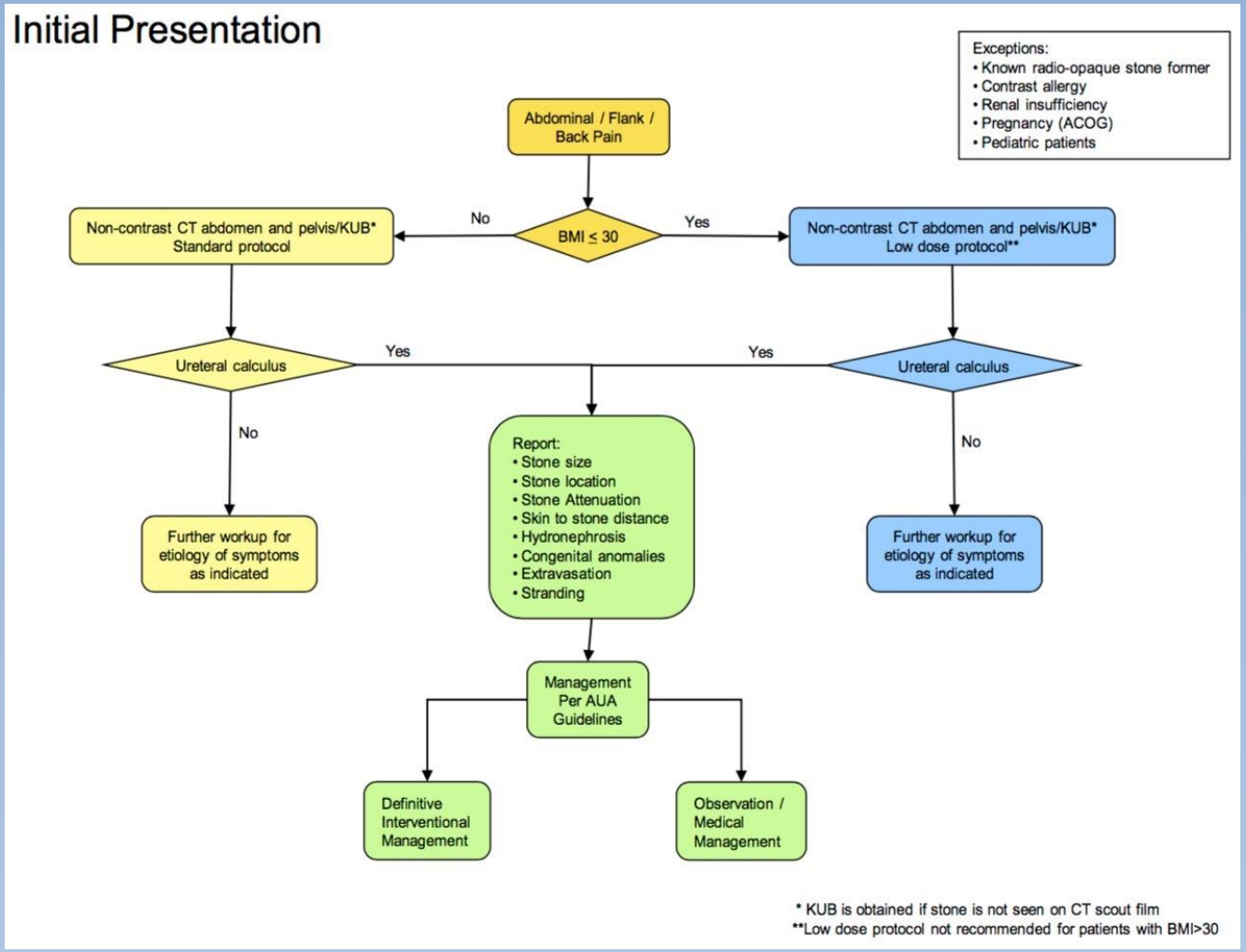
Conclusions

- ULDCT has significantly greater:
  - Sensitivity, Specificity, PPV, NPV
  - ~50% effective dose of a KUB
- ULDCT use would significantly reduce lifetime radiation exposure
- Limitations
  - Poor identification of sub 2mm calculi
  - Increased demands to review



Thank You!

Questions?



American Urological Association

European Association of Urology

Recommendation	LE	GR
NCCT should be used to confirm stone diagnosis in patients with acute flank pain, because it is superior to IVU (10).	1a	A

NCCT can detect uric acid and xanthine stones, which are radiolucent on plain films, but not indinavir stones

Fulgham PF, *AUA Guideline* May 2012
Turk C, *EAU Guideline* April 2014

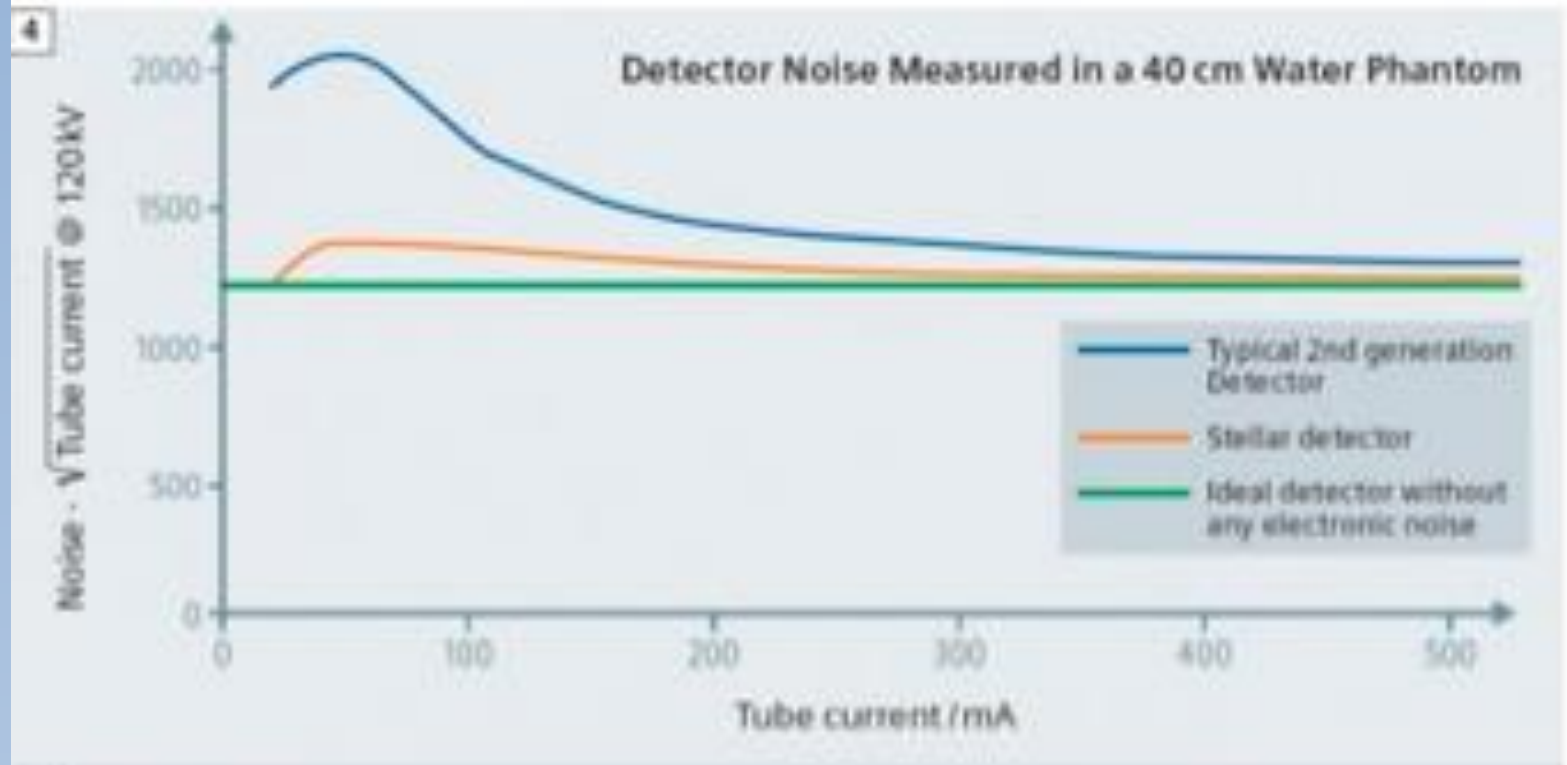
Radiation

- Per capita annual effective dose from CT:*
  USA 0.5 mSv in 1982
  3.0 mSv in 2006 (6x)
  Canada 0.19 mSv in 1991
  0.74 mSv in 2006 (3.9x)
- ED CT use in renal colic increased 7-12x 1996-2008**
- 79% evaluated for renal colic in ED underwent ≥2 CT, with median dose of 14.5 mSv***

*Chen J, J *Radiol Prot* 2010
**Dalziel JD, *Emerg Med J* 2013
***Broder J, *J Emerg Med*, 2007

MDCT dose: How low can we go? ALARA

- Ultra-low dose scanning possible with use of low noise detectors and iterative & model-based reconstruction
- Patient selection key



4 Reduced noise of the new Stellar Detector[5] measured with a 40 cm water phantom and compared to a conventional second-generation detector. Stellar produces almost no electronic noise (green line), benefiting low dose applications and large patient scans where signals are very low.