Comparison of Conventional and Triple Bolus CT Urography Protocols for Radiation Dose Reduction in Hematuria Evaluation

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Introduction

- Computed tomography urography (CTU) is the diagnostic tool of choice for the workup of hematuria.
- CT scans expose patients to harmful ionizing radiation.
  - 1.5-2% of cancers in the US are thought to be due to iatrogenic radiation exposure
- Concerns about radiation led to the ALARA (As Low As Reasonably Achievable) principle.

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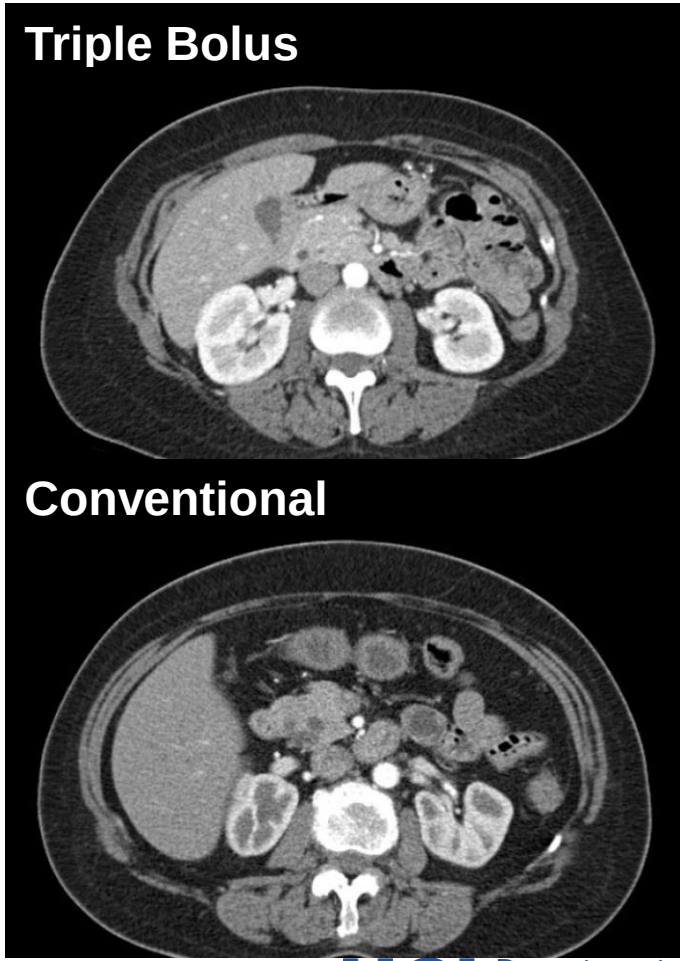
Introduction

- The triple bolus CT (TBCT) protocol is designed to reduce radiation exposure.

- Hypothesis: Triple bolus CT urography will detect pathology at an equal rate as conventional CT urography and expose patients to less radiation.

Methods

- 200 patients undergoing CTU for hematuria workup were randomly assigned to TBCT or CCT protocol.
- Total radiation exposure measured by dose-length product (DLP) was recorded from the radiology report.
- CT scan findings were recorded from the radiology report. Pathology detection rates were compared between TBCT and CCT.



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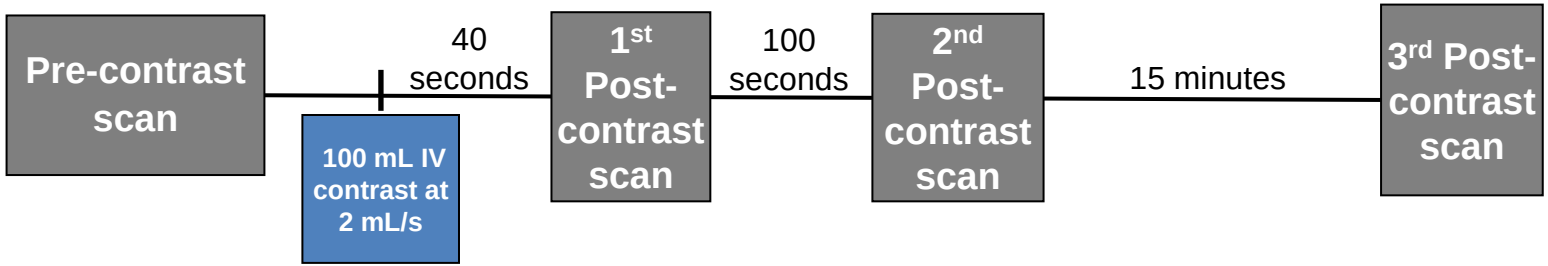
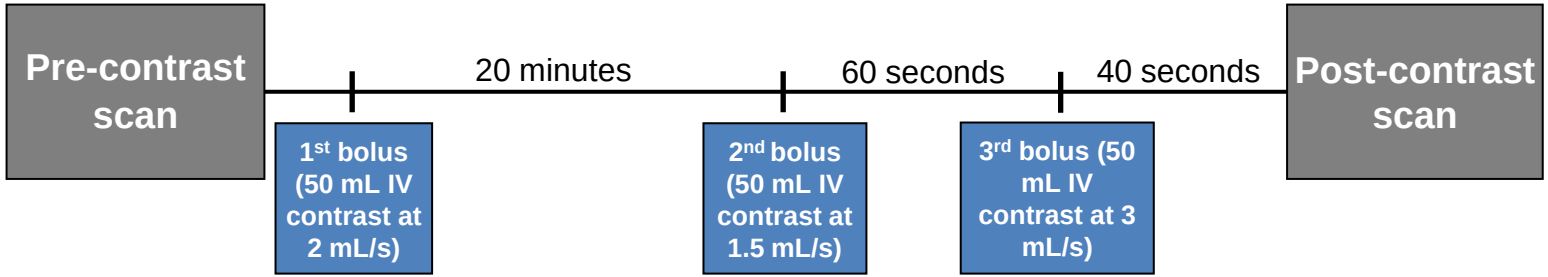
Conventional CT Protocol



Triple Bolus CT Protocol



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Descriptive Analysis

Variables	CCT (n=100)	TBCT (n=100)	p-value
Mean age, years (range)	60.2 (21-96)	61.2 (25-82)	0.65
Gender, N (%) Male Female	 57 (57%) 43 (43%)	 62 (62%) 38 (38%)	 0.47
Mean BMI, kg/m^2 (SD)	27.01 (4.85)	27.71 (6.17)	0.39
Creatinine, mg/dL(SD) Pre-scan Post-scan Change in creatinine	 0.88 (0.23) 0.84 (0.21) -0.05 (0.21)	 0.91 (0.19) 0.91 (0.17) 0.02 (0.10)	 0.46 0.11 0.09
Charlson Comorbidity Index (range)	2.75 (0-14)	2.77 (0-10)	0.96
Amount of IV contrast administered, mL	100 (85-150)	112 (75-150)	**<0.001**
CT scanner type, N (%) Siemens Sensation 64 Siemens Sensation 16 Philips iCT SP 128 Philips iCT SP 256	 68 (68%) 3 (3%) 17 (17%) 3 (3%)	 73 (73%) 10 (10%) 9 (9%) 3 (3%)	 0.09
Type of hematuria, N (%) Macroscopic Microscopic	 66 (66%) 34 (34%)	 63 (63%) 37 (37%)	0.66

Results

- TBCT reduced radiation exposure by 30% in patients with macroscopic hematuria.
- TBCT reduced radiation exposure by 38% in patients with microscopic hematuria.
- TBCT and CCT had similar pathology detection rates overall.

Radiation Exposure in DLP (mGy*cm)			
	CCT	TBCT	p-value
Macroscopic hematuria (n=66/63)	1752	1221	**<0.001***
Microscopic hematuria (n=34/37)	1640	1016	**<0.001***

Urological Pathology Detected (%)			
	CCT	TBCT	p-value
Macroscopic hematuria (n=66/63)	77%	73%	0.57
Microscopic hematuria (n=34/37)	53%	62%	0.42

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Macroscopic Hematuria			
Detection Rate, %	CCT (n=66)	TBCT (n=63)	p-value
Urological Pathology	77%	73%	0.57
Urolithiasis	30%	32%	0.86
Bladder Pathology	32%	22%	0.22
Renal Cyst	23%	21%	0.77
Urological Mass	12%	16%	0.54
Prostate Pathology	21%	24%	0.72
Other pathology	29%	29%	0.88

Microscopic Hematuria			
Detection Rate, %	CCT (n=34)	TBCT (n=37)	p-value
Urological Pathology	53%	62%	0.42
Renal Cyst	26%	24%	0.84
Urolithiasis	15%	19%	0.64
Bladder Pathology	24%	19%	0.63
Urological Mass	3%	11%	0.20
Prostate Pathology	15%	19%	0.64
Other macro/micro	29%	43%	0.23

Conclusions

- In the settings of macroscopic and microscopic hematuria evaluation, triple bolus CT reduces radiation exposure by 30% and 38% respectively.

- Triple bolus CT has an equivalent ability to detect pathology when compared to conventional CT for both macroscopic and microscopic hematuria.

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