Radiation Dose Variations: A Comparison Between an Academic Tertiary Care Center and Community Hospitals and Freestanding Imaging Centers

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Background:

Given the known risk of carcinogenesis, medical radiation exposure is an important parameter to track and evaluate.[1] Radiologists should follow the ALARA (as low as reasonably achievable) principle to minimize radiation doses.[2] In conjunction with the ALARA principle, radiology examination protocols created for specific clinical indications reduce patient's radiation exposure.[3]

Numerous examples are available where radiation exposure can be decreased while maintaining diagnostic value. For example, while renal masses may be completely evaluated with two phases, some protocols require up to five phases and provide up to 2.5 times as much radiation exposure. For renal stones, ACR Appropriateness Criteria® dictates that a noncontrast abdomen and pelvis CT, preferably with dose reduction techniques, is the most appropriate imaging modality for suspected renal calculi.[4] However, some practitioners order contrast enhanced studies for renal stone evaluation.

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Background - continued:

Imaging protocoling can be time consuming and complicated when advanced imaging techniques are utilized, as well as not being reimbursable. Many large academic tertiary care centers have entire departments dedicated to radiation safety. Highly qualified staff can construct, monitor, and adjust guidelines to optimize imaging protocols.

For community hospitals and freestanding imaging centers, these time-consuming activities can be burdensome. The additional radiologists, residents, and ancillary staff available at a large academic tertiary care center may provide additional resources for ordering providers, technologist questions, and efficient protocol updates.

Purpose:

To evaluate radiation dose exposure for abdominal and pelvic computed tomography in a large academic tertiary care center compared to community hospitals and freestanding imaging centers. Patients suspected of having renal masses or urolithiasis were included.

Materials and Methods:

- CT imaging reports were collected retrospectively from studies performed at a large academic tertiary care center (inside studies) and those performed at community hospitals or free-standing imaging centers (outside studies).
  - Search criteria included:
    - Patients age 18-89
    - Underwent evaluation for **renal stone** or **renal mass**
    - Obtained between 1-1-13 and 1-1-17
  - Search criteria excluded:
    - Other indications besides renal stone or renal mass
    - Known metastatic disease
    - Incomplete dosing information

Materials and Methods - continued:

- Parameters collected:
  - Age
  - Gender
  - Body mass index (BMI)
  - Type of scan performed
  - Number of imaging phases acquired
  - Tube Voltage peak (kVp)
  - Volume CT Dose Index
  - Dose Length Product total (DLP total)
  - Diagnostic acceptability of the image quality

Results – Renal **stone** evaluation:

- 15,988 inside studies were collected
  - 288 of these studies meeting inclusion and exclusion criteria were randomly selected and included
- 310 outside studies were collected
  - 72 of these studies met inclusion and exclusion criteria

- Statistically significant difference in renal **stone** evaluation cohort:
  - Fewer phases were obtained for renal stone inside studies compared to outside studies, 1.02 phases compared to 1.18 phases, respectively (P = <0.0001).
    - All inside studies were protocoled as noncontrast. Many outside studies were given IV contrast.

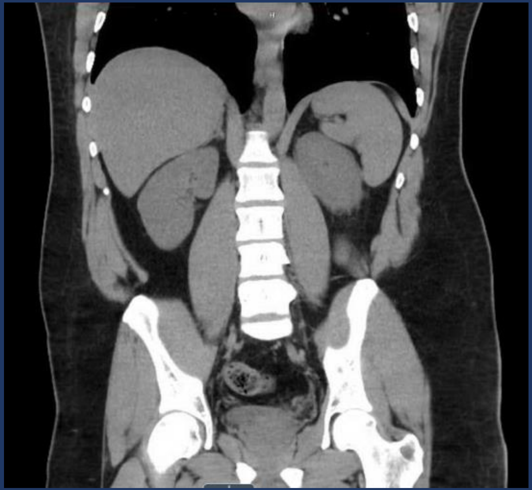
Results – Renal **stone** evaluation:

A

Total mAs 5204 Total DLP 568 mGycm

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm
Patient Position H-SP					
Topogram	1	100	36 mA	0.08 L	3
Abdomen	2	100	274 / 220	10.66 L	565

B



Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)
1	Scout	-	-	-
2	Helical	S28.250-I464.250	27.28	1476.90
			Total Exam DLP:	1476.90

- Both A and B are noncontrast CT abdomen and pelvis studies to evaluate a patient with flank pain.
- Both patients have a BMI of 35.
- The inside study (A) has a DLP of 568 mGy-cm. The outside study (B) has a DLP of 1476 mGy-cm.
- Patient B was exposed to nearly three times as much radiation as patient A.
- Study B used a higher kVp and did not use auto tube current modulation.

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Results – Renal **mass** evaluation:

- 24,343 inside studies were collected
  - 117 of these studies meeting inclusion and exclusion criteria were randomly selected and included
- 707 outside studies were collected
  - 28 of these studies met inclusion and exclusion criteria
- Statistically significant difference in renal **mass** evaluation cohort:
  - No statistically significant differences in the number of phases for renal mass evaluation.
  - Given the relatively small number of renal mass cases collected, further isolated renal mass specific data analysis was not performed.

Results - Renal **<u>stone</u>** and renal **<u>mass</u>** combined:

- No significant difference between inside and outside studies for these variables:
  - Age, Gender, IV contrast use, BMI, BMI distribution, or Diagnostic quality
- Statistically significant difference between inside and outside studies for these variables:
  - kVp (P = <0.0001)
    - 46.2% of inside studies used 100 kVp
    - All outside studies used 120 kVp or higher.
  - Use of tube current modulation (P = <0.0001)
    - 100% of inside studies and 81% of outside studies used tube current modulation.
  - Total DLP (P = 0.029)
    - The median total DLP was 784 mGy-cm for inside studies and 939 mGy-cm for outside studies, a difference in radiation dose exposure of 16.5%.

Conclusion:

- Radiation dose exposure is 16.5% lower at an academic tertiary care center compared to community hospitals and free-standing imaging centers when utilizing CT to evaluate renal mass and renal stones.
- Renal **mass** radiation dose exposure difference attributed to:
  - Tube current modulation
  - kVp settings
- Renal **stone** radiation dose exposure differences attributed to:
  - Tube current modulation
  - kVp settings
  - Number of phases acquired

Conclusion - continued:

- As experts in radiology, it is our duty to assist the ordering provider to ensure the appropriate test is performed with efficiency, accuracy, and the ALARA principle in mind.
- To optimally decrease radiation doses, a comprehensive approach is required. Establishing a radiation dose reduction committee, including a physicist, has been shown to be highly effective in decreasing patient radiation exposure. Other techniques to decrease radiation exposure include avoiding unnecessary CT examinations, adjusting individual scanning parameters, optimizing protocols, using shielding and dose monitoring, implementing computer-based dose modulation software, as well as educating referring physicians and radiologic technologists.[5] Increasing public awareness that imaging of adequate diagnostic value can be performed with less radiation may also be a powerful tool.
- This information can help community hospitals and freestanding imaging centers focus on measurable and effective areas of improvement for patient radiation dose reduction.

References

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Thank you!

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