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CHANGE IN RADIATION EXPOSITION IN PATIENTS WITH RENAL COLIC 2004–2014

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Abstract. We have made a retrospective analysis of the diagnostic radiologic approach ten years ago and in the present. The purpose of our analysis was to realise if the advanced technology means advantage or disadvantage for patients with renal colic. We concluded that there is a significant elevation in the radiation dose used for the diagnosis of the patients hospitalised with renal colic. That is the reason why the guidelines change from year to year and only by following their recommendations and protocols we should avoid unnecessary exposition. Raising the dose of radiation by advanced diagnostic methods influences not only the patients but all the participants during these procedures. It makes the working environment more harmful nowadays than a decade ago.

Keywords: radiation dose, renal colic, harms.

AIMS AND BACKGROUND

Imaging for urinary calculous disease accounts for a significant portion of the total imaging performed by urologists[1]. Patients with suspected ureteral calculi often undergo repeated imaging studies before, during and after treatment, and patients with urinary calculous disease are at high risk for recurrence[2]. Imaging accounts for 16% of the total expenditure for each episode of care in the management of urinary calculous disease[3].

In symptomatic patients with renal colic and radio-opaque stones, a sonogram and KUB (kidney, ureter, bladder) radiography provide sufficient initial imaging to guide the need for observation, interval imaging or secondary treatment as indicated. For those with radiolucent stones, however, low-dose non-contrast computed tomography (NCCT) will optimally identify residual fragments or obstruction[4].

Ionising radiation is known to potentially harm through deterministic and stochastic effects. Deterministic effects (e.g. erythema of the skin and generation of cataracts) occur at a given threshold, and the effect is proportionate to the dose.

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Stochastic effects (e.g. the induction of secondary cancers or hereditary defects) may occur at any dose. The probability that a stochastic effect will occur increases with the dose, but the severity of the effect is independent of the dose. Deterministic effects are rarely encountered with diagnostic radiation doses associated with the management of ureteral calculous disease. Stochastic effects are currently believed to be low-threshold events linearly correlated with dose[5].

In general, younger patients, patients with genetic instability and pregnant patients are at higher risk of suffering long-term harms as the result of radiation exposure.

It is well-known that humans are permanently exposed to environmental radiation both natural and artificial. For example the maximum radiation dose emitted by building materials is 1.5 mSv per year (Ref. 6).

It is useful to quantify the risk of radiation exposure to patients and healthcare providers using 'effective dose'. Effective dose (in mSv) estimates the potential adverse biologic effect of the sum of the equivalent doses of radiation to exposed organs; therefore, radiation exposure from various types of diagnostic imaging studies can be compared in terms of relative biologic risk. Effective dose cannot be equated to the actual absorbed dose for any individual. The actual absorbed dose for an individual will depend on the scanning protocol and the equipment with which it is performed. There is compelling evidence of wide variability in the effective dose produced during the same kind of examination (e.g. CT of the abdomen and pelvis) within an imaging facility and between imaging facilities[7,8]. Average effective doses for imaging studies commonly performed in the evaluation and management of ureteral calculous disease are given in Table 1. Actual doses in clinical practice may be considerably higher owing to a number of factors.

Table 1. Estimated effective dose (mSv) by type of exam

Type of exam	Effective dose (mSv)	Reference
Ultrasound (US)		
Abdomen and pelvis US	0.0	
Magnetic Resonance Imaging (MRI)		
Abdomen and pelvis MRI	0.0	
Conventional Radiography (CR)		
KUB	0.7	A
KUB with tomograms	3.9	B
IVU	3.0	A, C
Computed Tomography (CT)		
Non-contrast CT, abdomen and pelvis	10.0	D,E
Without and with contrast CT, abdomen and pelvis (2-phase)	15.0	F
Without and with contrast CT, abdomen and pelvis (3-phase)	20.0	A
Non-contrast CT, abdomen and pelvis (low-dose protocol)	3.0	G

EXPERIMENTAL

Medical technology and the protocols in establishing diagnosis in patients with renal colic and urolithiasis have been changed in the past decade. We have made a retrospective analysis of the diagnostic radiologic approach ten years ago and in the present. The purpose of our analysis was to realise if the advanced technology means advantage or disadvantage for patients with renal colic.

RESULTS

Out of 132 patients hospitalised for renal colic in 2004 in 128 a KUB (kidney, ureter, bladder) plain radiography was performed, and the other 4 were excluded because of pregnancy, where an ultrasound was the first and only choice in diagnosis. Additionally, an ultrasound was performed in 17% and an IVU in 82%. That means that maximum radiation dose that patients underwent during the hospitalisation a decade ago did not go over 3.7 mSv. The sensitivity of both ultrasound and IVU is 61 and 70%, respectively, with specificity 97% for ultrasound and 95% for IVU, so the diagnosis was well established.

On the other side, we have analysed hospitalised patients with renal colic diagnosed during 2014, a total of 113, in all of them KUB plain radiography performed. The sensitivity and specificity of KUB radiography is 44–77 and 80–87%, respectively. Ultrasound was performed in 93% of the patients, IVU in 57% of the patients and enhanced CT in 43% of the patients. By means of all these data we found out that maximum exposition dose of radiation was 28.7 mSv (Fig. 1).

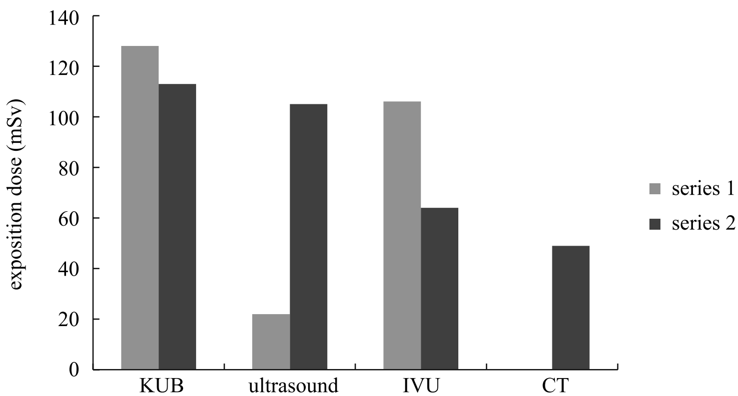

Fig. 1. Maximum exposition dose of radiation of patients

CONCLUSIONS

All imaging studies using ionising radiation should aspire to the principle As Low As Reasonably Achievable (ALARA)[9] attempting to expose the patient to the least ionising radiation that will give an adequate answer to the present clinical question. This is the reason why when two or more imaging studies have equal or nearly equal clinical effectiveness, the study with the least ionising radiation should be selected[10].

Optimisation of selected studies should be pursued. For example, the sensitivity of abdominal ultrasound or KUB radiography for the detection of a ureteral calculus may be optimised by withholding food and fluid prior to the examination to reduce the adverse effects of bowel gas on sensitivity and specificity[11].

Optimisation of CT scans includes limited scanning protocols confined to an anatomic region of interest (e.g. pelvic CT) for evaluation of the distal ureter, adjustments of CT parameters for tissue thickness and body habitus and limitation of phases (e.g. non-contrast only or combined injection and delayed phases) to reduce total radiation exposure. Specific protocols to reduce radiation exposure for the detection of ureteral calculous disease have been successful in lowering the effective dose for a standard abdominal and pelvic CT scan from 10 to 3 mSv (Ref. 12).

Considering all of the above we concluded that there is a significant elevation in the radiation dose used for the diagnosis of the patients hospitalised with renal colic. That is the reason why the guidelines change from year to year and only by following their recommendations and protocols we should avoid unnecessary exposition.

It is very important while making decision for choosing diagnostic methods to take medical history about previous radiation expositions[13]. Continuous updates and training of general practitioners as well should be performed in order to know where to direct the patients[14].

When a clinical question can be answered equally or near equally by two or more imaging modalities regarding their specificity and sensitivity, it is the modality with the least harm and lowest cost that should be selected.

Raising the dose of radiation by advanced diagnostic methods influences not only the patients but all the participants during these procedures. It makes the working environment more harmful nowadays than a decade ago.

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