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Variables Affecting Radiation Exposure in Patients under Going Endo-Urological Procedures

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Abstract

Introduction: Previously we have published data showing how clinician awareness surrounding radiation doses from common diagnostic modalities is poor. Evidence suggests that radiation exposure, from diagnostic and interventional procedures is placing patients at a small but significant increased risk of malignancy. As the usage of radiation in endourological surgery increases, urologists need to have an understanding of the variables affecting perioperative radiation exposure. Here we look at how the operating consultant, the patient triage status (elective vs. emergency admission) and the endourological procedure performed impacts upon perioperative radiation exposure.

Method: One hundred patients, who had undergone an endourological procedure in 2012 were randomly selected. The image intensifiers were interrogated for stored data of radiation dose and screening times. Computerised patient records provided the consultant's identity (A-D), the patient's triage status and the exact endourological procedure performed.

Results: There was no difference in radiation exposure when comparing elective and emergency patients. Endourological procedures requiring therapeutic intervention led to higher levels of radiation exposure when compared with diagnostic endourological procedures (p value<0.05). The operating consultant significantly varied the radiation exposure. Consultant B's radiation dosages and screening times were significantly lower compared to consultants A, C and D (p values<0.05).

Conclusion: The operating consultant causes a significant variation in the perioperative radiation dosage. This could be due to a subjective judgment about the importance of minimising perioperative radiation exposure. Alternatively it could be due to the consultant's operating technique, the communication methods used with the radiographer or the consultant's own awareness about the risks of radiation exposure. With the usage of perioperative radiation increasing, further studies are warranted to better understand the variables that affect and increase its use. This will allow future surgeons to consciously reduce perioperative exposure and patient harm.

Keywords: Perioperative radiation exposure; Endourology; Radiation risk

Introduction

Previously we have published work about a patient's radiation exposure in the first year after presentation with urolithiasis [1]. This referred to a patient's significant radiation exposure from diagnostic imaging. Increasingly patients are being exposed to higher levels of radiation due to the increased usage of diagnostic imaging; which is exposing them to a greater iatrogenic risk [2,3]. In imaging however the radiation use is finite and the urologist is easily able to control the radiation exposure by ordering scans or cancelling any diagnostic process he feels is not necessary.

Radiation exposure from any diagnostic or therapeutic endourological intervention is variable. Variables such as the operating urologist, the exact procedure being carried out, the radiographer, the patient's diagnosis and the patient's urinary tract anatomy must also change the amount of perioperative radiation required.

In interventional endourology imaging is used to assess the patency of the urinary tract. Previous studies have shown that atypical radiation dose during ureteroscopy is 1.13 mSv [4]. This paper investigates how a patient's radiation exposure from imaging during endourological procedures changes with three peri-operative variables. Firstly, with the specific urological procedure being carried out. Secondly, whether there is any difference according to the operating consultant surgeon and lastly according to whether the case is an emergency or an elective case. Methods for reducing intraoperative radiation exposure have already been devised [5]. This study helps us to identify which variables subject a patient to higher levels radiation so that in the future we can consciously reduce the levels of radiation exposure.

Method

A hundred patients who had an endourological procedure were selected at random by the coding department. Patients' with the Read coding classifications of either 'endoscopic retrograde pyelography' (M301) or 'unspecified examination of the ureter' (M309) qualified for selection. All patients presented to the Princess Royal University Hospital, Bromley at sometime throughout the year of 2012. No demographics were used to exclude the patient from the data set. Radiation dose and screening times were collected retrospectively for the 100 patients. The hospitals CRIS computer system[1] records the radiation dose, in milli-gray, and the peri-operative screening time, in minutes[2] and provided a database for data collection. Using the hospitals' electronic patient records extra details were obtained

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including the patient's triage status (elective or emergency), the operating consultant and the exact endourological intervention carried out. The endourological interventions were classified according to the table below. None of the procedures involved bilateral ureteroscopy.

Classification Group

Diagnostic Pyelography

Pyelography+proceed

Diagnostic Bilateral pyelography

Bilateral pyelography+proceed

Diagnostic Ureteroscopy

Ureteroscopy+proceed

The procedures were separated into groups according to their triage status, operating consultant and procedure classification. The data sets were then analysed to see if there was any difference in radiation exposure and screening time.

All results underwent normality testing using the D'Agnostino normality test, which confirmed non-parametric data. The results were then analysed using the Student's T-test for unpaired data. An online calculator was used for the statistical calculations[3]. All T-tests were carried out with a null hypothesis of $\mu_1=\mu_2$ between the two data sets. Data was analysed at the 95% confidence interval, rejecting the null hypothesis if the p value was less the 0.05.

Results

The average age of the patients was 58 years old. The age ranged from 20 to 85 years old. There were 56 males and 44 females in the sample group. The indication for endo-urological intervention was primarily either stone disease or for diagnosing an unknown cause of ureteric obstruction.

Six out of the 100 patients had no screening time recorded on the CRIS system and 17 of the procedures were not carried out by one the four urology consultants working at the Princess Royal University Hospital. These 17 procedures were excluded from analysis when the radiation exposure and screening times for each operating consultant were analysed.

The results are shown in Table 1 below. Of the 83 consultant performed procedures 31 were performed by consultant A, 21 by consultant B, 10 by consultant C and 21 by consultant D. T-test analysis showed operations performed by consultant B used statistically less screening time and radiation when compared with consultants A and C (p values <0.05). Consultant D had statistically comparable screening times to consultant B (p value>0.05) but still the radiation dose per procedure was still statistically less for consultant B than for D (p value <0.05).

The data shows a lower mean radiation dose for elective procedures compared with emergency procedures (2686.46 vs. 2717.7 mGYCM^2) but the difference is not statistically significant (p value >0.05). Conversely the screening times used for elective cases are longer than for emergency ones (0.420 vs. 0.358 mins), again this difference is of no statistical significance (p value >0.05).

When comparing diagnostic to therapeutic procedures the results were significant. The t-test for radiation dose differences between the pyelography and pyelography+proceed groups was statistically significant (p value=0.017, <0.05), the screening times however was not statistically significant and were comparable (p value=0.057, >0.05). Simple diagnostic pyelography did have significantly less radiation and lower screening times when compared with simple diagnostic ureteroscopy (radiation p value=0.013, <0.05; screening time p value=0.016, <0.05). Rather surprisingly there was no statistical difference in radiation dose between unilateral and bilateral pyelography groups (p value=0.252, >0.05) but there was a statistical difference in the screening time (p value=0.007, <0.05). Bilateral pyelography

	Radiation (MGYCM2)			Screening time (mins)		
Consultants	**No. of patients**	**Average**	**Standard deviation**	**No. of patients**	**Average**	**Standard deviation**
A	31	2808.090	2684.28	27	0.437	0.355
B	21	793.810	785.97	20	0.203	0.380
C	10	5521.990	5160.81	10	0.684	0.602
D	21	2854.429	2757.45	21	0.375	0.382
Elective	56	2686.463	2827.03	52	0.420	0.434
Emergency	44	2717.700	3112.52	42	0.358	0.440
Pyelography						
Diagnostic Pyelography	9	590.900	464.900	8	0.076	0.032
Pyelography+ Proceed	30	2820.770	2647.370	27	0.430	0.502
Diagnostic Bilateral Pyelography	8	1091.500	1163.510	8	0.367	0.424
Bilateral Pyelography+ Proceed	6	2658.330	1029.630	6	0.425	0.317
Ureteroscopy (all unilateral)						
Diagnostic Ureteroscopy	24	3496.829	3253.918	24	0.514	0.479
Ureteroscopy + Proceed	23	3107.565	3769.759	21	0.339	0.359

Table 1: Radiation dose and Screening time data. Separated out into operating consultant, triage status and procedure classification groups.

Data Sets used in T-Test	**Radiation P value**	**Screening P value**
Consultant A vs. Consultant B	0.002	0.035
Consultant A vs. Consultant C	0.351	0.132
Consultant A vs. Consultant D	0.952	0.564
Consultant B vs. Consultant C	0.0002	0.012
Consultant B vs. Consultant D	0.002	0.156
Consultant C vs. Consultant D	0.069	0.092
Elective vs. Emergency	0.052	0.062
Diagnostic pyelography vs.pyelography + proceed	0.017	0.057
Diagnostic bilateral pyelography vs. bilateral pyelography+proceed	0.023	0.784
Diagnostic pyelography vs. diagnostic bilateral pyelography	0.252	0.007
Pyelography+proceed vs. bilateral pyelography+ proceed	0.884	0.982
Diagnostic pyelography vs. diagnostic ureteroscopy	0.013	0.016
Pyelography+proceed vs. ureteroscopy+proceed	0.746	0.486
Diagnostic ureteroscopy vs. ureteroscopy+proceed	0.706	0.177

Table 2: T-test P values.

[1]Communication recording information system (CRIS) used at the Princess Royal University Hospital to record radiation data and patient imaging details.

[2]There is not an exact correlation between radiation dose and screening time. The X-ray machine automatically changes the strength of radiation used according to the size of the patient. i.e. For a patient with a high BMI, they receive a stronger radiation dose.

[3]Statistical QuickCalcs at http://graphpad.com/quickcalcs/contMenu/

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had a statistically lower radiation dose than bilateral pyelography + proceed (p value=0.023, <0.05) but the screening times were again not statistically different (p value=0.784, >0.05).

There was no statistical difference in radiation dose or screening time between patients with ureteroscopy and ureteroscopy+proceed. Similarly there was no difference between ureteroscopy+proceed and pyelography+proceed (Tables 1 and 2), (Figures 1 and 2).

Discussion

The results show that the operating consultant significantly influences the perioperative radiation dose and screening time. Consultant B either relies far less on fluoroscopy than his piers or he is acutely aware of its harmful effects and consciously tries to minimize its use. Whatever the cause of this consultant's significantly lower radiation doses, research into finding out the reason must be carried out with sensitivity. A consultant urologist may become defensive if informed that they were subjecting their patients to higher levels of radiation and therefore potential harm. Presumably the answer lies in how the consultant communicates with the radiographer, in how accurately the x-ray equipment is positioned, in the experience of the consultant and in the consultants case load i.e. does that particular consultant get referred all the complex stone disease cases? This would definitely increase the perioperative radiation usage. In addition some urologists may be particularly wary of their own radiation exposure and risk [5,6]. Conversely other consultants may believe that the intraoperative radiation exposure is not in fact an important issue; operative accuracy is the only thing that's important when a patient is in theatre, and fluoroscopy is a tool that can be used to maximise accuracy and operative outcomes.

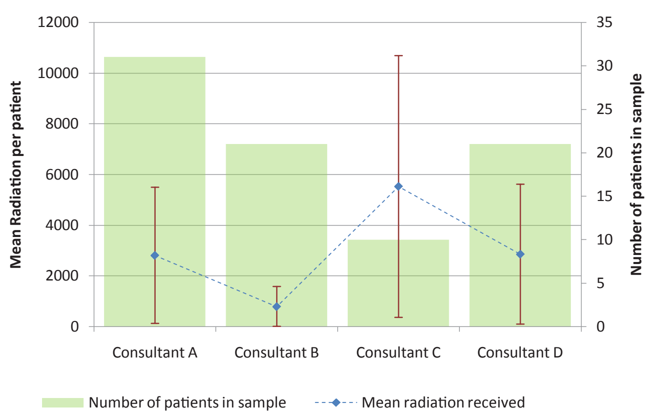

Figure 1: Radiation exposure mean and standard deviations (in red) plotted for each consultant.

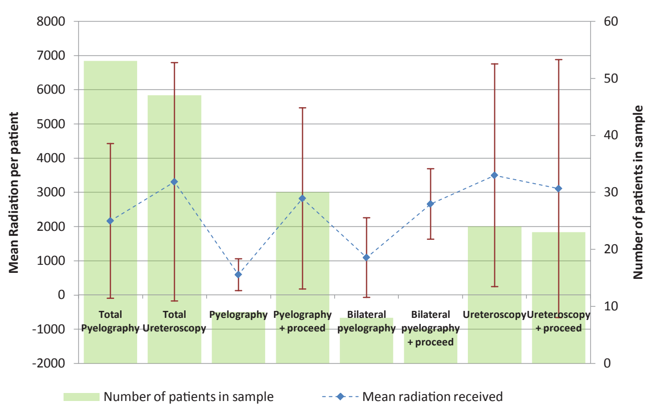

Figure 2: Radiation exposure means and standard deviations plotted for each procedure classification group.

There is no significant difference in radiation dose and screening time between emergency and elective procedures. It could have been hypothesized that elective procedures could require less peri-operative radiation, as CT and USS imaging prior to admission may make endourological procedures more predictable, thus reducing perioperative imaging.

When the diagnostic pyelography and diagnostic ureteroscopy groups were compared both the radiation dose and the screening times showed statistically higher means in the diagnostic ureteroscopy group. Presumably this is due to repeated images being required during scoping as opposed to the single image of the urinary tract required during pyelography. Similarly statistically significant results were obtained in radiation dosage when comparing a diagnostic procedure with its respective therapeutic procedure (i.e. pyelography vs. pyelography+proceed). Again this is likely to be due to the repeated images being required during a therapeutic procedure; for example during stenting or biopsy. The sample sizes for the groups were small and larger studies are required to confirm these findings.

Surprisingly when unilateral pyelography was compared with bilateral pyelography only the screening time produced a statistically significant result (p value=0.007<0.05). The p value in radiation dose comparison was 0.252 (p value >0.05). This may well be due to the small group sizes and larger studies should produce significant results in both parameters. But possibly the indications for unilateral and bilateral pyelography are different and so the radiation dose for bilateral pyelography is not necessarily twice that of the unilateral pyelography.

It may never been known how harmful a particular imaging technique is to a patient and the increased risk of developing a malignancy. However, what is known is that the total dosage from diagnostic imaging has increased exponentially in recent years mostly due to the use of CT scanners . Using the results from this paper, urologists can be more aware of the factors that increase radiation dosage and screening time. In particular we have found that radiation exposure is particularly subjective to the consultant in charge of the procedure and can be minimised with conscientious use of the image intensifier.

Conclusion

Due to increasing life expectancy, patient exposure to radiation is increasing. Radiation is known to be carcinogenic. In endourology the patient is exposed to radiation. We have shown that a therapeutic endourological procedure when compared to a diagnostic endourological procedure significantly increases the patients' radiation exposure. We have also shown that diagnostic ureteroscopy using significantly more radiation than diagnostic pyelography. Most importantly we have shown that the operating consultant has a significant impact on a patient's perioperative radiation exposure. A consultant's conscious awareness of how to reduce the perioperative exposure does produce significant results and reduces the risks to the patient and potential harm.

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