

Assessment of Radiation Dose Received By Personnel and Patients in Fluoroscopic Urology in Selected Saudi Arabia Hospitals



Medical Science

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ABSTRACT

The aim of the current study was to assess the dose received by the fluoroscopic urology staff and patients. The method was based on thermoluminescence (TLD) crystal measurement which attached to patient heads, waist and legs as well as to urology staff under lead apron. The analyzed results showed that: the dose received by the patient's head (eyes) was 3.2, 3.1 mSv, waist was 5, 4.3 mSv and the legs were 3.5, 3.3 mSv per month respectively, and that received by the assistant urologist and radiation technologist was 0.3 mSv and by the operation preparer, nurse, and anesthetist were 0.27 while the urologist received 0.28 mSv. Also the dose level found to be decreases from the center of exposure towards the room walls inversely following the inverse square law and was significantly ($R^2 = 0.9$) fitted to the equation of the form: $y=0.190x^{(-0.86)}$ at East direction of the room, $y=0.138x^{(-0.85)}$ at the West direction of the room, $y=0.091x^{(-0.086)}$ at North direction of the room and at the South direction was: $y=0.057x^{(-0.86)}$.

INTRODUCTION

The application of ionizing radiation has been under control by ICRP (international commission on radiological protection), especially in the medical field applications (diagnostic and therapy) and industry. Such control of ionizing radiation have to be in agreement with ALARA concept which states that ionizing radiation should be used "as low as reasonably achievable" [1]. And the ultimate goal of a radiation safety program in radiology examinations is to provide regulatory oversight, education, minimizing radiation exposure and enhance the effective usage of radiation sources in all fields, medical and industry. From the reviewing of previous studies, the personnel exposure dose is varies widely between equipment and facilities [2], in addition to some sources that could lead to underperformances or discrepancies that in turn could lead to high exposure dose in radiology examination as in the following cases: Complacency, Faulty reasoning, Lack of knowledge, under reading, poor communication, miscellaneous, and complications [3] and the fact stated that: the transmitted radiation from the primary beam is 5% -15% i.e. 85-95% represent the absorption and scattering as well as the continuing exposure in fluoroscopic all have been consider as impact factors to increase the patient and staff radiation dose. One radiologic model under concern is the fluoroscopic technique and it is relevant exposure dose in staff and patient. Since the fluoroscopic studies of urologic system have been as essential and inevitable assessment method for shock wave lithotripsy, nephrolithotomy, ureteric stenting, ureterorenoscopy and retrograde pyelography; the risk of radiation exposure hazards to staff and patients assumed to be increase [4, 5]. Further from the report of UNSCEAR, [6] and the previous information about the risk of fluoroscopic exposure, the researchers assume that, the fluoroscopic examinations done in our national medical centers in Saudi Arabia may give high dose to staff and patients which in turn may lead to radiation diseases in the future. From the general work experience in Saudi Arabia and survey regarding the utilization of fluoroscopic urology and the collected data from picture archiving computerized system (PACS) at hospitals which in turn directed the current paper manuscript into retrospective study, the researchers deduce that: there is extensive use of fluoroscopic model and further being motivated to assess the dose receive by the staff and patient during fluoroscopic examinations, the exposure around the patient, and at different points at the fluoroscopic room. And also to deduce whether it exceeds the recommended limit (20 mSv/year) or the maximal total body exposure over 5 years that should not exceed 100 mSv as stated by ICRP [7]. ICRP has also recommends some limits for the vital organs for instance: the maximum permissible exposure is 150 mSv for the eye and 500 mSv for the

skin as well as the extremities [7]. The staff of fluoroscopic urology and all other radiology practitioner should be subjected to monthly screening or each three months to quantify the radiation exposure amount that should not exceeds the annual permissible limits [8]. And since many organizations such as World Health Organization, International Agency for Research on Cancer, Agency for Toxic Substances and Disease Registry of the Centers for Disease Control and Prevention and the National Institute of Environmental Health Sciences [2], have classified x-ray as carcinogenic factor, hence the monthly screening for radiology staff to assess their received doses and further assessing the potential cancer risks has become inevitable.

METHODOLOGY

A thermoluminescence dosimeter TLD crystal: Cylindrical (GR200A) TLD chips manufactured by FIMEL, France, made of Lithium Fluoride doped with Magnesium, Copper, and Phosphorus (LiF: Mg, Cu, P) with a linear response of 1 μ Gy-12 Gy has been used for measuring the dose received by the staff and patients. TLD annealing oven (TLDO, PTW, Freiburg, Germany): A programmable annealing oven (TLDO) manufactured by PTW- was used. It is designed for very precise and reproducible temperature for TLDs treatment. Before irradiating or utilizing the TLDs detectors, they have been heated according to the 7 segments annealing program, and before reading they were heated according to the 5 segments preheating program. During the heating cycle, the hot air stream was circulated by a built-in fan to ensure equal temperature distribution throughout the oven volume. All TLDs were annealed in annealing oven at 240°C for 10 min, followed by fast cooling by opening the oven door. Then the TLDs chips were placed on the right and left sides of the patient's at head, pelvic and the ankle during screening. And the individual staff members (urologist, 2 assistant urologists, radiology technologist, nurse and anesthetist) worn the TLDs chips at waist and chest sites under lead apron, while there were some TLDs distributed at specific distances in the diagnostic room as shown in Figure (1). After the procedures of one month of fluoroscopic urology, the TLDs were collected and a reading process by using TLD-reader (PLC3 manufactured by FIMEL in France), the irradiated TLDs were picked by an electrical vacuum plaser and placed in a small blank steal cupels, taking into account the numerical arrangement of the TLDs, and then the cupels were recognized inside PCL3 loading Holder. Inside the TLD reader there were circular halls where the TLDs are released from the loaded holder and stay inside it one by one for 60 seconds on 155°C as a pre-heating temperature and 260°C as post- heating. After that, the TLDs complete their rotation reaching a photo-multiplier

tube (PMT) which is supplied by 850 volts. The signals were detected after passing through one or more filtration processes. The output light from the TLDs is proportional to the quantity of the absorbed dose. All this procedure takes about 130 second. And the TLDs were already calibrated; the signal in nanocoulomb (nC) was divided by 6.2163 to get absorbed dose in μGy , multiplying it by quality factor of radiation used to get effective dose in μSv (for x-ray quality factor = 1) then divided by 1000 to convert it into mSv.

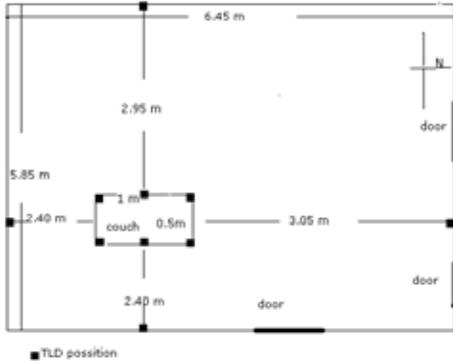


Figure 1: shows the sketch map for the fluoroscopic urology room and the position of the TLDs

Results and Discussion:

The following section will show the results related to doses measured for personnel and Patients in Fluoroscopic Urology. Specifically the doses at the sides of the diagnostic couch i.e. right side and the left side at the level of the patient’s anatomical regions (Head, Waist and Legs), the doses at different points in the examination room in the direction of North, South, East and West. In addition to the doses at the walls (North, South, East and West) and the doses received by the operation staff.

Figure 2: shows the radiation doses at anatomical regions for the Right and Left side of the patient. It reveals that the dose received by the head (eyes) was 3.2, 3.1 mSv, waist was 5, 4.3 mSv and the legs were 3.5, 3.3 mSv during the Fluoroscopic Urology exam per month for right and left side respectively. In contrast with MPD for the eye and extremities which are 150 mSv and 500 mSv respectively, the annual received doses by eyes and the extremities will be 38.4, 37.2 mSv, and 60, 51.5 mSv at right and left respectively. The high doses at right side ascribed to the site of operation and are equivalent to 26% of annual dose of the eye and 12% of annual dose of the extremities. However the variation of received dose by increment or decrement may occur depending on the workload per month, therefore the precautions should be taken into account unless to exceed the MPD.

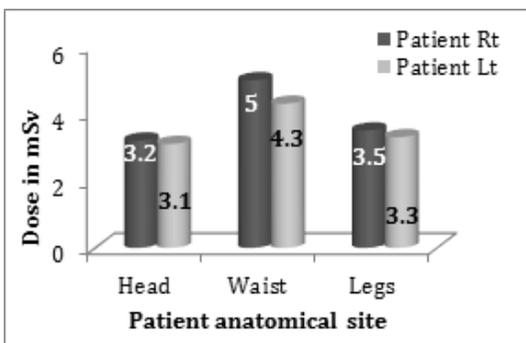


Figure 2: shows the radiation doses at anatomical regions for the Right and Left side of the patient

Figure 3: shows the exposure doses received by the personnel during Fluoroscopic Urology exam. The data reveals that the high exposure dose was received by the assistance urology surgeons (A. Uro-Surg) and the radiation technologist which was 0.3 mSv in mean, the operation preparer, the urology surgeon and the Anesthetist received 0.27 mSv. These results were for one month if we consider it for a year it will be equivalent to 3.6 mSv for the assistant urologists and the radiation technologist while the urologist, operation preparer and the anesthetist received 3.2 mSv per year. Such results fall within the range of doses received by the staff during renal stone removal in which they received 1.1 mSv, 2.4 mSv, 0.9 mSv and 0.7 mSv by urologist, radiologist, nurse and anesthetist respectively during a month [9].

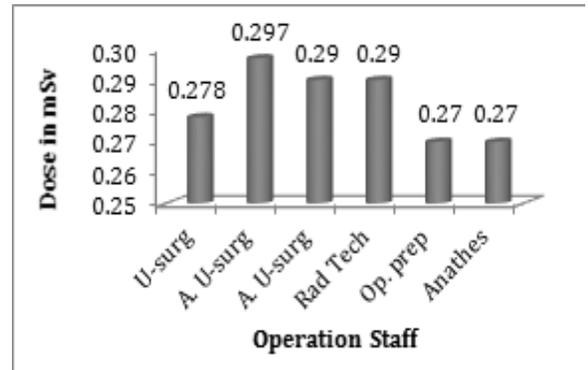


Figure 3: shows the exposure doses received by the personnel during Fluoroscopic Urology exam in selective Saudi Hospitals Staff.

Figure 4: shows the radiation doses at different points towards the walls from the center of exposure. The exposure was measured in nanocoulomb (nC) and converted to mSv. And it showed that the radiation exposure decreases exponentially from the center of exposure towards the walls i.e. to North, South, East and West directions. The form of correlation between the exposure and the distance could be fitted in the following equation: at East direction of the room, at the West direction of the room, at North direction of the room and at the South direction was: , such correlation is significant at $R^2 = 0.9$, which agree with the inverse square law [10]. The following plotted graphs enhance determination of the exposure level at any point where one of the staff standing in the room during the operation.

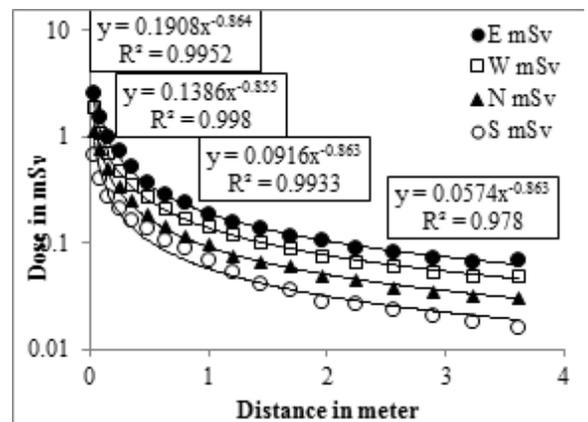


Figure 5: shows the radiation doses at different points towards the walls from the center of exposure.

CONCLUSION:

Radiation exposure due to urologic fluoroscopy is inevitable for the staff and patients, however for the staff may depends on the workload hence could lead to high exposure that approaching or exceeds the MPD. Therefore the worth points to be recommended are: the weekly screening and dose assessment for the staff and limiting the numbers of patients operated and following the concept of as low as reasonable achievable (ALARA).

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