Risk of Radiation Exposure During PCNL

Heshmatollah Soufi Majidpour

Purpose: Fluoroscopic guidance is a routine practice in endourology; both the physician and the assistances are exposed to some radiation via radiation scatter. Measurement of radiation doses in staff is important, but often these data are not reported.

Materials and Methods: We measured radiation exposure during 100 cases of percutaneous nephrolithotomy using lithium fluoride thermoluminescent dosimeters placed at the head, eye glasses, the fingers, and the legs of the operating surgeon, the assistant, and the circulating nurse.

Results: The mean screening time was 4.5 minutes (range, 1 to 8 minutes) with mean fluoroscopy tube potential of 73 kVp, and mean tube current of 2.8 mA. The estimated scatter exposure rate at 40 cm from the x-ray beam was 0.47, 0.04, 0.21, and 4.1 μGy to the head, eye glasses, the fingers, and the legs of the operating surgeon, respectively. The estimated scatter exposure rate at different points from the x-ray beam was 0.05, 0.01, 0.025, and 0.1 μGy to the head, eye glasses, the fingers, and the legs of the assistant, respectively and the estimated scatter exposure rate at all different points from the x-ray beam for circulating nurse was 0 μGy.

Conclusion: Fluoroscopic screening results in radiation exposure of the medical staff. The surgeon received the maximum radiation exposure, mostly to the legs and very least to the eyes. The assistant received less radiation exposure than the surgeon and the nurse did not receive significant amount of radiation.

Keywords: operating rooms, radiation, percutaneous nephrolithotomy

Urol J. 2010;7:87-9.
www.uj.unrc.ir

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a common urologic practice for treatment of upper urinary tract calculi, tumors, and stricture. The practice of PCNL, having been refined over time, continues to evolve and has largely replaced open stone surgery for the treatment of complex upper tract calculi unsuitable for extracorporeal shockwave lithotripsy or ureteroscopy, resulting in stone removal with less morbidity, shorter convalescence, and reduced cost compared with open surgery. [1,2]

Fluoroscopic guidance is the preferred technique for most of the stone therapies with PCNL. As endourology has become an important practice of urology, the use of fluoroscopic guidance has increased the exposure of urologists to the possibly deleterious effects of radiation.[3] The radiation exposure of staff increases due to scattered radiation produced from interaction of the primary radiation beam with the patient and the operating table. The medical staff standing next to the C-arm fluoroscopy unit are subjected to receive scatter radiation from all directions. The lower and

Department of Urology, Touhid Hospital, Kurdistan University of Medical Sciences, Sanandaj, Kurdistan, Iran

Corresponding Author:
Heshmatollah Soufi Majidpour, MD
Department of Urology, Touhid Hospital, Kurdistan University of Medical Sciences, Sanandaj, Kurdistan, Iran
Tel: +98 918 1710 360
Fax: +98 871 3561 814
E-mail: hmajidpour@yahoo.com

Received June 2009
Accepted January 2010

upper extremities are in radiation risk. Standard radiation protection protocol requires the use of 0.35 mm lead aprons and thyroid shields for the operating surgeon and 0.25 mm lead aprons for other operating room staff.[4] The aprons and shields reduce transmission by 100-fold or more and hence gonadal and thyroid doses are minimal.[5,6] In this study, we attempted to evaluate the doses of radiation received by the operating room personnel during PCNL at endourology centers to assess the radiation risk and the radiation exposure rate at different parts of the body.

MATERIALS AND METHODS

One hundred patients underwent PCNL. The patients were placed initially in a lithotomy position for retrograde ureteral catheter placement in the renal pelvis/superior calyx on the stone bearing side under fluoroscopic guidance. Thereafter, the patient was placed in a prone position and the location of the stones in the kidney was confirmed using air contrast instilled via the ureteral catheter. The operating urologist established the tracts by puncturing the desired calyces and dilating the tracts under fluoroscopic guidance. Stone fragmentation was performed using pneumatic lithotripsy and the fragments were removed with stone grasping forceps. At the end of the procedure, fluoroscopic screening of the renal area was performed to ensure stone clearance using a mobile multidirectional C-arm fluoroscopy unit with an under the couch x-ray tube and an over the couch image intensifier (SHIMADZU OPESCOPE 50 N, Japan). The fluoroscopy unit has a combined energy/current (kVp/mAmp) selector, which controls the radiation output at the tube and an Automatic Brightness Control (ABC) mode, which selects the optimal tube voltage and current, automatically.

The urologist wore lead aprons, thyroid shields (0.5 mm equivalent lead thickness) (Meditronics, Iran), and lead glasses during the entire procedure. Other operating room staff wore lead aprons and thyroid shields (0.5 mm equivalent lead thickness) (Meditronics, Iran).

To measure the radiation exposure, lithium fluoride thermoluminescent dosimeter chips (TLDs) have been placed at the head, eyeglasses, the fingers, and the legs of the operating surgeon, the assistant, and the circulating nurse. Thermo luminescentdosimeter chips were later read in a TLD reader. An estimation of radiation exposure to the operating surgeon was made based on average screening exposure time and surgeon's position.

RESULTS

The mean time of performing PCNL procedure was 116 minutes (range, 42 to 160 minutes). The mean fluoroscopy screening time during the procedure was 4.5 minutes (range, 1 to 8 minutes). Fluoroscopy screening time during the procedure decreased with increasing experience of surgeon, resulting in radiation exposure decrease.

The mean fluoroscopy tube potential was 73 kVp and tube current mean was 2.8 mA. The additional radiation exposure was not monitored.

The estimated scatter exposure rate at 40 cm from the x-ray beam of the operating surgeon for each procedure was: 0.47 μGy to the head, 0.04 μGy to the eye glasses, 0.21 μGy to the fingers, and 4.1 μGy to the legs. The estimated scatter exposure rate at different points from the x-ray beam for the assistant was: 0.05 μGy to the head, 0.01 μGy to the eye glasses, 0.025 μGy to the fingers, and 0.1 μGy to the legs. The estimated scatter exposure rate at all different points from the x-ray beam for circulating nurse was: zero (0).

DISCUSSION

Fluoroscopic imaging is widely practiced in various interventional procedures. Although collimation of the x-ray beam prevents direct radiation exposure to the urologist and assisting personnel, the patient becomes a secondary source of exposure through radiation scatter by absorbing radiation during the procedure.[7] Therefore, it is imperative to measure radiation exposure to patients and the staff to maintain safe levels of cumulative radiation.

The International Commission on Radiation Protection recommends an effective dose of 20 mSv per year over a defined period of 5 years on average as the occupational dose limit.[8] According to our findings, radiation exposure dose to the

operating room staff is less than 1% of permissible annual limits; however, radiation exposure dose to the urologist was greater in comparison to the assistant and the nurse, which is due to his/her closer proximity to the x-ray tube. Our results clearly place the intensive care environment well below the hazardous level of radiation exposure, even in the case of pregnant staff.

In our study, the highest radiation exposure dose was to the legs for the operating surgeon and assistant with 4.1 μGy and 0.1 μGy, respectively. Hellawell and colleagues have shown that the surgeon received the highest radiation exposure with the lower leg (11.6 ± 2.7 μGy) and the foot (6.4 ± 1.8 μGy) receiving more radiation than the eyes (1.9 ± 0.5 μGy) and the hands (2.7 ± 0.7 μGy).[9]

The radiation exposure to the fingers of urologists reported in previous studies are as below: 360 μGy (Kumari), 145 μGy (Bowshar), 340 μGy (Law), 5800 μGy (Rao), and 280 μGy (Kumar), while it was 0.2 μGy in our study. Probably, it is due to advances in technology, the urologist experience, fluoroscopy time, and intensive care from radiation exposure.[10]

Rao and associates documented a mean total radiation dose of 5.2 mSv to the hands, 7.5 mSv to the fingers, and 1.6 mSv to the eyes, with the mean fluoroscopy time of 21.9 minutes, which was very high in comparison to that cited in literature.[11] In a study by Kumari and coworkers, the mean radiation exposure dose to the patient was 0.56 ± 0.35 mSv, while the mean incident radiation exposure to the finger of the urologist was 0.28 ± 0.13 mSv.[12]

CONCLUSION

Our results demonstrated that the operating room staff are within the safe radiation dose limits during PCNL; however, following proper precautions as well as efficient fluoroscopy and avoiding useless exposure during the procedure can further reduce the dose, especially the scattered radiation. Care must be taken by all the staff operating in the field to achieve as low as reasonably achievable dose by adhering to good practices.

ACKNOWLEDGEMENT

I would like to thank the director and members of Atomic Energy Organization of Iran for their cooperation. This work was supported by grant from Kurdistan University of Medical Sciences.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Brannen GE, Bush WH, Correa RJ, Gibbons RP, Elder JS. Kidney stone removal: percutaneous versus surgical lithotomy. J Urol. 1985;133:6-12.
2. Lam HS, Lingeman JE, Mosbaugh PG, et al. Evolution of the technique of combination therapy for staghorn calculi: a decreasing role for extracorporeal shock wave lithotripsy. J Urol. 1992;148:1058-62.
3. Kumari G, Kumar P, Wadhwa P, Aron M, Gupta NP, Dogra PN. Radiation exposure to the patient and operating room personnel during percutaneous nephrolithotomy. Int Urol Nephrol. 2006;38:207-10.
4. Links A. Medical and Dental Guidance Notes. A Good Practice Guide on all Aspects of Ionising Radiation Protection in the Clinical Environment. J Radiol Prot. 2002;22:334.
5. Kicken PJ, Bos AJ. Effectiveness of lead aprons in vascular radiology: results of clinical measurements. Radiology. 1995;197:473-8.
6. Christodoulou EG, Goodsitt MM, Larson SC, Darner KL, Satti J, Chan HP. Evaluation of the transmitted exposure through lead equivalent aprons used in a radiology department, including the contribution from backscatter. Med Phys. 2003;30:1033-8.
7. Giblin JG, Rubenstein J, Taylor A, Pahira J. Radiation risk to the urologist during endourologic procedures, and a new shield that reduces exposure. Urology. 1996;48:624-7.
8. [No author listed]. International Commission on Radiological Protection [homepage on the Internet]. Summary Recommendation [cited 2008 Feb 1]. Available from: http://www.icrp.org/docs/Summary_B-scan_ICRP_60_ Ann_ICRP_1990_Recs.pdf.
9. Hellawell GO, Mutch SJ, Thevendran G, Wells E, Morgan RJ. Radiation exposure and the urologist: what are the risks? J Urol. 2005;174:948-52; discussion 52.
10. Kumar P. Radiation safety issues in fluoroscopy during percutaneous nephrolithotomy. Urol J. 2008;5:15-23.
11. Rao PN, Faulkner K, Sweeney JK, Asbury DL, Sambrook P, Blacklock NJ. Radiation dose to patient and staff during percutaneous nephrostolithotomy. Br J Urol. 1987;59:508-12.
12. Bush WH, Jones D, Brannen GE. Radiation dose to personnel during percutaneous renal calculus removal. AJR Am J Roentgenol. 1985;145:1261-4.