Research Article

iMedPub Journals
http://www.imedpub.com

Journal of Bone Reports & Recommendations
ISSN 2469-6684

2015
Vol. 1 No. 2:13

DOI: 10.4172/2469-6684.100013

Radiation exposure of Filipino Orthopedic residents in Tertiary level hospitals

Mamer S. Rosario[1],
Venancio P. Garduce[1],
Mario B. Geronilla[1],
Joseph Keat T. Sison[1], and
Enrique Leonardo C. Pasion[1*]

Department of Orthopaedics, East Avenue Medical Center

Corresponding author: Enrique Leonardo

rich.pasion@gmail.com

Department of Orthopaedics, East Avenue Medical Center, EastAvenue, Diliman Quezon City Metro, Manila1101, Philippines.

Tel: +639236863484

Citation: Rosario MS, Garduce VP, Geronilla MB, et al.Radiation exposure of Filipino Orthopedic residents in Tertiary level hospitals. Bone Rep Recommendations. 2016, 1:2.

Abstract

This multi-center, prospective one-year study aims to know if Filipino orthopedic residents are receiving radiation exposure levels beyond the International Commission on Radiological Protection (ICRP) occupational radiation dose limit of 20 mSv per year. Twenty (20) Filipino orthopedic residents of four (4) Metro Manila-based tertiary institutions, from January 1 to December 31, 2013, were equipped with optically stimulated luminescence (OSL) dosimeters (*InLight, Landauer Inc.*) placed inside their lead aprons during procedures that involve radiation exposure. The dosimeters were collected after the year, and submitted to the Philippine Nuclear Research Institute (PNRI) for reading. One-sample t-test and Wilcoxon-signed Rank Test were used to compare radiation exposure level with the occupational radiation dose limit, and conclusion was based on a 5% level of significance. On the average, radiation exposure level of these residents was 1.17 ± 0.24 (SD), values ranged from 0.82 to 1.57. Mean difference of -18.8 from radiation dose limit was significantly lower (95% CI: -18.9; p<0.000). In conclusion, the radiation dosage of a Filipino orthopedic resident is well within the ICRP recommended guidelines. The authors recommend that all orthopedic residents must still wear dosimeter badges and regularly monitor their radiation exposure, and that all efforts should be made to reduce radiation to a minimum.

Keywords: Orthopedic residents; Optically stimulated luminescence dosimeters; Radiation exposure; International commission on radiological protection (ICRP).

Received: October 14, 2015, **Accepted:** November 18, 2015, **Published:** November 25, 2015

Introduction

Ionizing radiation can be energetic enough to overcome electron bonds orbiting atoms and molecules, and consequently knock electrons out of their orbits. The most common scenario in a biologic material exposed to x-ray, which is a form of ionizing radiation, is the formation of hydroxyl radicals from x-ray interactions with water molecules, which in turn, interact with nearby DNA to cause strand breaks or base damage. Radiation-induced damage can be rapidly repaired by various systems within the cell, but DNA double-strand breaks are less easily repaired, and occasional misrepair can lead to induction of point mutations, chromosomal translocations, and gene fusions, all of which are linked to cancer induction [1].

Studies on radiation exposure among orthopedic doctors done in other countries have shown that none of the participants approached the recommended maximum radiation dose levels, whether for the whole body [2,3] the eyes[2,3] the hands[2,4] or the thyroid [4,5]. The results can be reassuring, but in a study by Herscovici and Sanders [6], it was concluded that despite the absence of studies showing toxic effects resulting from long-term exposure to low-dose radiation, risks are still assumed. This finding may put a stress on orthopedic residents and trainees, as certain studies [3,4] have shown that orthopedic trainees possess the risk of over-radiating oneself as the duration and number of exposures increase, and that the risks increase significantly with longer durations of fluoroscopy [7], more spinal imaging exposures [8], and increased duration of trauma posts [9]. Other studies [3,10] have investigated on the role of distance from the radiation source, and consequently found that in orthopedic surgical procedures needing radiologic imaging, there is a higher risk of exposure for the assistant surgeon as compared to the orthopedic surgeon he or she is assisting. This brings to mind orthopedic residents again being at risk. These findings therefore raise the possibility that radiation exposures among orthopedic residents could possibly exceed dose limits given circumstances that involve many, and repeated times of exposure to ionizing radiation.

It can be observed that Filipino orthopedic residents play a major role in most radiographic procedures in Philippine tertiary level hospitals, either as C-arm operators during surgery or as assists in radiographic positioning of patients. In some, if not in most major tertiary hospitals in the Philippines, orthopedic trainees get much radiation exposures during x-ray procedures both intra- and extra-operatively as radiographic positioning of patients up to the act of x-ray shooting has been a major responsibility, if not a primary task, in the Philippine orthopedic residency program. And yet this is not to mention, the many C-arm- and fluoroscopy-guided orthopedic surgical procedures that Filipino orthopedic residents primarily do or assist in, and thereby get exposed to. In most training institutions in this country, it is the radiology resident who gets issued with a film badge when in fact, it is the orthopedic resident who usually participates in diagnostic radiologic procedures, and who in the process, risks exposure to too much ionizing radiation.

Obviously, radiological risk to orthopedic surgeons and trainees is a topic of major concern in other countries. However, not a single study has investigated on radiation exposures among Filipino orthopedic residents. Hence, these results of studies investigating on radiological risks to orthopedic surgeons and trainees, if applied to our setting, may possibly underestimate the concern given the myriad of occupational radiation exposures Filipino orthopedic residents could not avoid. Unless a similar study on Filipino orthopedic residents can show the same results, it is possible to err when presuming that occupational radiation exposure among Filipino orthopedic residents is, just like in other countries as their studies have shown, way below the occupational radiation dose limit.

Such a study should also promote the awareness, and the responsibility to adhere to safety measures regarding occupational radiation exposure, among Filipino orthopedic residents. Khan et al., in their study [11], found it unfortunate that basic surgical trainees are lacking in the essential knowledge of ionizing radiation, and that most of the trainees are not adhering to radiation safety principles. The same scenario could be happening in our setting. Hopefully, this study can bring not only the attention of the whole Filipino orthopedic community, but also the hospital radiation physicists, and consequently the hospital management, to the issue.

The general objective of the study is to compare the yearly radiation exposure level of Filipino orthopedic residents with the yearly occupational radiation dose limit (20 mSv) set by the International Commission on Radiological Protection (ICRP) [12], and the specific objectives are:

To determine the yearly radiation exposure level of Filipino orthopedic residents; and

To compare the yearly radiation exposure level of Filipino orthopedic residents with the yearly occupational radiation dose limit (20 mSv) set by the International Commission on Radiological Protection (ICRP)

Materials and Methods

Twenty (20) Filipino orthopedic residents from 4 Metro Manila-based tertiary institutions, namely East Avenue Medical Center (EAMC, n=5), Armed Forces of the Philippines Medical Center (AFPMC, n=7), Veterans Memorial Medical Center (VMMC, n=3), and University of Santo Tomas Hospital (USTH, n=5) were given the optically stimulated luminescence (OSL) dosimeters (*InLight, Landauer Inc.*) to be placed on the chest beneath their lead aprons during radiologic procedures when doing radiographic positioning, and during surgeries with image intensifier use. No one was pregnant during the time of study, and all 4 institutions had functional image intensifiers and x-ray machines. The radiation dosage from consecutive orthopedic surgeries requiring the use of an image intensifier and from radiographic positioning of patients for x-rays was measured over a 1-year period. The dosimeters were collected after a year and submitted for reading (*InLight, Landauer Inc.*) to the Philippine Nuclear Research Institute (PNRI). The accumulated radiation exposure, in mSv, for each participant for the one-year study duration (i.e. 6 readings per participant) is basically the dosimeter reading for each participant after the year of study.

All valid data from evaluable subjects were included in the analysis. Missing values were not replaced or estimated during analysis. Summary statistics were presented in tables or graphs and reported as mean ± SD or proportion (%) as appropriate. Radiation exposure level was tested for normality. One-sample t-test and Wilcoxon-signed Rank Test were used to compare radiation exposure level with occupational radiation dose limit of 20 mSv. Two-tailed and one-tailed 95% confidence intervals were estimated. Conclusions were based on a 5% level of significance. SPSS v20 was used in data processing and analysis.

Results

Twenty (20) Filipino orthopedic residents affiliated in four (4) tertiary institutions in Metro Manila from January 1 to December 31, 2013 participated in the study. **Table 1** describes the study sample according to sex, training institution, and year level distribution.

On the average, radiation exposure level of these residents was

Table 1 Distribution of the resident participants according to sex, training institution, and level in training.

Resident Participant Characteristics		Distribution of Participants (n=20)
Sex	Male	18
	Female	2
Institution	EAMC	5
	USTH	5
	VMMC	3
	AFPMC	7
Level in Training	First Year	14
	Second Year	4
	Third Year	2
	Fourth Year	0
	Fifth Year	0

Journal of Bone Reports & Recommendations
ISSN 2469-6684
2015
Vol. 1 No. 2:13

1.17 ± 0.24 (SD), values ranged from 0.82 to 1.57. Mean difference of -18.8 from radiation dose limit was significantly lower (95% CI: -18.9; p<0.000; **Figure 1).**

Tables 2, 3, 4, and 5 show the cumulative radiation dosage to the residents of each of the 4 participating institutions over the 1-year period. The International Committee for Radiological Protection (ICRP) recommended maximum exposure dosage per year is shown for comparison in **Table 6.** The radiation dosages fell well within the ICRP recommendations.

Discussion

Most personnel who work with radiation use dosimeter badges to monitor radiation dosage received. Once they have exceeded the ICRP recommended maximum dosages, a thorough examination is usually conducted by the regulatory body, of the design and operational aspects of protection in the installation concerned. Filipino orthopedic residents, unfortunately, do not monitor their radiation exposure, and there is some concern among them about the amount of radiation that they are exposed to in the course of work. This is especially so now that there is an increasing preference for the use of image intensifier guided procedures in orthopedic work, such as the use of closed locked intramedullary nails and percutaneous cannulated screws for fixation of fractures. These procedures require the surgeon and his assistants to spend a considerable amount of time in close proximity to the radiation beam. The data from this study show that the mean difference from radiation dose limit was significantly lower, and the radiation dosage of a Filipino orthopedic resident in a busy orthopedic unit is well within the ICRP recommended guidelines. Other researchers have also shown that the radiation dosage from fluoroscope guided procedures in orthopedic surgery is within acceptable limits [7,13]. This should be reassuring to the residents and other operating room personnel.

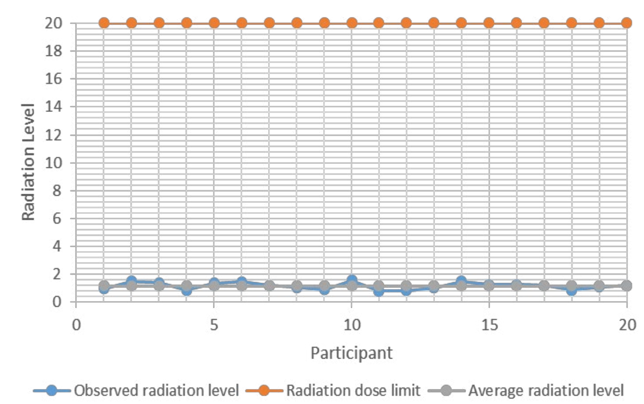

Figure 1 Radiation exposure of the 20 resident participants after 1 year.

Table 2 Cumulative radiation dosage of the 5 resident participants of the EAMC over 1 year.

Dosimeter No.	Radiation in mSv	Dose in Relation to the ICRP Radiation Dose Limit
1316	1.52	< 20
453	1.41	< 20
648	1.46	< 20
2658	1.57	< 20
555	1.49	< 20

Table 3 Cumulative radiation dosage of the 5 resident participants of the USTH over 1 year.

Dosimeter No.	Radiation in mSv	Dose in Relation to the ICRP Radiation Dose Limit
2315	0.88	< 20
2659	0.91	< 20
2622	0.82	< 20
1973	0.85	< 20
1361	0.89	< 20

Table 4 Cumulative radiation dosage of the 3 resident participants of the VMMC over 1 year.

Dosimeter No.	Radiation in mSv	Dose in Relation to the ICRP Radiation Dose Limit
527	0.96	< 20
1807	1.03	< 20
32	1.12	< 20

Table 5 Cumulative radiation dosage of the 7 resident participants of the AFPMC over 1 year.

Dosimeter No.	Radiation in mSv	Dose in Relation to the ICRP Radiation Dose Limit
771	1.37	< 20
2575	1.19	< 20
2301	1.08	< 20
1964	1.26	< 20
769	1.26	< 20
672	1.19	< 20
1351	1.21	< 20

Table 6 International Commission for Radiation Protection (ICRP) recommended dose limits for radiation workers and for the general population.

Applications	Dose Limits – Radiation Workers	Dose Limits – Public
Annual effective dose	20 mSv/year (averaged over 5 years	1 mSv/year
Annual equivalent dose in:		
Lens of eye	150 mSv	15 mSv
Skin	500 mSv	50 mSv
Hand/feet	500 mSv	

Although this study showed radiation dosage from radiographic positioning of patients and from the use of an image intensifier to be within safe limits, the ICRP acknowledges that the long term effects of any additional amounts of radiation from non-natural sources are not known. Hence all efforts should be made to reduce this radiation to a minimum. As an orthopedic surgeon will continue to use the image intensifier for several decades of his professional career, it is important that proper use of protective shielding be encouraged.

It is also important to take proper care of the lead apron. Crumpling of the lead apron will break the integrity of the lead fiber shielding. Therefore the lead apron should be properly hung up after use. The integrity of the lead apron should be checked regularly and this can be done easily by taking a radiograph of the apron. Cracks in the apron will show on the radiograph.

There are some good practices that the resident can adopt to reduce the radiation to him- or herself. The simple act of standing back during screening greatly reduces radiation exposure because of the inverse square law. The radiation scatter drops by a square of the distance the resident positions himself from the operation side. The amount of radiation scatter from the primary beam can be reduced by the positioning of the image intensifier and the resident should be aware of this. The radiation back scatter is greatest when working with the femur because of the bulk of the thigh. Giachino and Cheng [14] had shown that positioning the C-arm with the radiation source directed from lateral to medial when used in the horizontal mode increases the back scatter from the thigh to the surgeon. The preferred position should have the radiation source directed from medial to lateral, with the bulk of the thigh attenuating the scatter. Mahaisavariya et al. [15] had described an innovative method of hanging a lead apron between the C-arm and the surgeon so as to reduce the back scatter to the surgeon.

Recommendations

The authors recommend that all orthopedic residents must wear dosimeter badges and regularly monitor their occupational radiation exposure. There is no other way to be sure about being within the safe range of radiation dosage other than to keep to a regular monitoring scheme. And for this to be possible, the institution and its administrative staff should invest on the matter and allocate budget to ensure that its staff concerned, especially orthopedic residents, is equipped with dosimeter badges and undergoes regular radiation exposure monitoring.

All efforts should be made by the orthopedic resident to reduce radiation to a minimum. It is very important that proper use of protective shielding be encouraged. Various devices can be used to reduce the radiation to the hands such as radiolucent drives for the drill or distal targeting devices. Complex fractures should best be done with an experienced consultant, or be delegated to experienced senior residents. Use of real-time fluoroscopic screening should be discouraged.

References

1 Mitelman F, Johansson B, Mertens FE (2007) Mitelman database of chromosome aberrations in cancer. Cancer genome anatomy project.

2 Smith GL, Briggs TW, Lavy CB, et al. (1992) Ionising radiation: are orthopedic surgeons at risk? Ann R Coll Surg Engl. 74: 326-328.

3 Tasbas BA, Yagmur Iu MF, Bayrakci K, et al. (2003) Which one is at risk in intraoperative fluoroscopy? Assistant surgeon or orthopaedic surgeon? Arch Orthop Trauma Surg. 123: 242-244.

4 Bahari S, Morris S, Broe D, et al. (2006) Radiation exposure of the hands and thyroid gland during percutaneous wiring of wrist and hand procedures. Acta Orthop Belg. 72: 194-198.

5 Muller LP, Suffner J, Mohr W, et al. (1997) Effectiveness of lead thyroid shield for reducing roentgen ray exposure in trauma surgery interventions of the lower leg. Unfallchirurgie. 23: 246-251.

6 Herscovici D, Jr., Sanders RW. (2000) The effects, risks, and guidelines for radiation use in orthopedic surgery. Clin Orthop Relat Res. 375: 126-132.

7 Sanders R, Koval KJ, Di Pasquale T, et al. (1993) Exposure of the orthopedic surgeon to radiation. J Bone Joint Surg Am. 75: 326-330.

8 Oddy MJ, Aldam CH. (2006) Ionising radiation exposure to orthopaedic trainees: the effect of subspecialty training. Ann R Coll Surg Engl. 88: 297-301.

9 Jones DG, Stoddart J (1998) Radiation use in the orthopaedic theatre: a prospective audit. Aust N Z J Surg. 68: 782-784.

10 Alonso JA, Shaw DL, Maxwell A, et al. (2001) Scattered radiation during fixation of hip fractures: is distance alone enough protection? J Bone Joint Surg Br. 83: 815-818.

11 Khan FR, Ul-Abadin Z, Rauf S, et al. (2010) Awareness and attitudes amongst basic surgical trainees regarding radiation in orthopaedic trauma surgery. Biomed Imaging Interv J. 6: e25.

12 International Commission Radiological Protection, 1990. Recommendations of the International Commission on Radiological Protection No. 60. ICRP 21: 72-79.

13 Levin PE, Scheon RW, Browner BD. (1987) Radiation exposure to the surgeon during closed interlocking intramedullary nailing. J Bone Joint Surg. 69: 761-765.

14 Giachino AA, Cheng M. (1980) Irradiation of the surgeon during pinning of femoral fractures. J Bone Joint Surg. 62: 227-279.

15 Mahaisavariya B, Suibnugarn C, Laupattarakasem W, Kowsuwon W (1990) A lead apron for closed femoral nailing. J Bone Joint Surg 72: 922.