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Research Article

Orthopedist's Hands Radiation Doses during Orthopedic Surgery Procedures

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Abstract: Interventional radiology now is common and favorite practice for orthopedists during surgeries; However orthopedist and the staff in the operating theatre exposed to a significant radiation dose during these procedures. This study aimed to evaluate hands radiation dose for orthopedists during the interventional, propose methods of radiation dose reduction and to compare the results with the literature. A total of 56 procedures of four different orthopedic surgeries were performed in three different centers in Khartoum-State. A calibrated 72 Thermoluminescence dosimeter (TLDs) had been used to measure orthopedists hand's radiation doses. The mean fluoroscopic exposure factors for all procedures were 72.4 kVp ±13, 1.4 mA±0.6 and 0.79 ±0.1 mins, the mean radiation dose for the hands of orthopedist was 0.27 mGy per procedures ±0.09. Compared results with previous studies, the present results were lower than previous studies. Radiation dose reduction techniques are recommended when heavy load co-exist.
Keywords: Orthopedics, Hand dose, Radiation.

INTRODUCTION

Fluoroscopy is the heart of the most of interventional procedures, where prolong lower intensity beam is used. The number of orthopedic procedures requiring the use of fluoroscopic guidance has increased over the recent years [1]. It is now accepted that closed operative procedures are the treatment of choice in many types of complex fractures because of their lower infection and, smaller incision wounds and relatively low morbidity at implant removal [2]. Interventional procedures considered the medical imaging exposures, imparting the highest radiation doses to the patients. Medical specialists and other health professionals working in interventional suites are subjected to high level of scattered radiation [3]. In Europe, the European council directive 97/43, EURATOM on health protection of individual against the dangers of ionizing radiation considered the medical exposure of interventional procedures as "special practice" involving high radiation doses to patient and requiring quality assurance programs including patient dose evaluation. Practitioner performing such procedures shall obtain appropriate trainings in radiation protection under the responsibility of the member state of the European Union [4]. Over the world the radiation protection for patients and staff is one of the main issues for interventional radiology (IR). The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA), together with many other international and national organizations and scientific and professional societies have put all their efforts into improving radiation safety in IR over the last years .In Sudan, due to the lower infrastructure of health care services and lack of measurement devices such as Electronic personnel dosimeter (EPD) and Thermoluminescence dosimeter (TLD), no radiation dose monitoring, following or even studies performed during these procedures according to author's knowledge. So this paper will seek to provide first-hand data on radiation doses for hands of orthopedist in this field.

The objectives of this study were to: (i) measure and evaluate orthopedist's hands radiation dose during four different orthopedic surgeries and (ii) propose methods of staff dose reduction (iii) compare the resultant radiation doses with worldwide published data to evaluate local practice of interventional orthopedist in three centers in Khartoum state.

MATERIALS AND METHODS

Dose Measurements

TLD of lithium fluoride (LiF: Mg, Ti: P, GR: 200) chips doped with magnesium and titanium were used (Fimel-France). A total of 72 TLD chips were used in this study. The TLDs were calibrated under reproducible reference conditions using the same X-ray machine (Siremobil 2000) against an ionization chamber model CONNY (***PTW***, Physikalisch-Technische Werkstätten GmbH). TLD calibration was performed according to the protocol reported by Sulieman *et al.* [5].

TLD chips were handled with vacuum tweezers to avoid scratching the surface. The TLD signal was read using a manual TLD reader (Fimel-France).

The readout was carried at a 100°C preheat temperature and reading temperature of 100–300°C with heating rate 10°C s^{-1}. Before each irradiation all dosimeters were annealed in a computerized annealing oven (TLDO; PTW, Freiburg, Germany). The mean background signal for un irradiated TLDs was subtracted before any calculation. The minimum detection limit was determined to be 15 µGy. The linearity of the TLD's response for the range of doses used in this study has been verified.

The uncertainty of TLD reading was estimated to be less than 10% of all measurements procedures.

Three different x-ray machines were used throughout this study, in three centers Omdurman Military hospital and Ribat National hospital which are governmental hospital and Mulazimeen hospital which is a private center. Table 1 illustrates the main specifications of the X-ray C-arm machines. All three machines passed successfully quality control tests performed by Sudan Atomic Energy Commission (SAEC).

Orthopedist's Hand Radiation Dose

A total of 56 procedures were performed in three hospitals. Orthopedists performed Dynamic hip Screw (DHS, 19 procedures), Dynamic cannulated screw (DCS, 18 procedures), intramedullary nailing of peritrochanteric fractures (11 procedures) and internal fixation of malleolar fractures (8 procedures). Three TLDs were enclosed in a transparent polyethylene foil envelope and were placed over the palm of the hand under the surgery gloves and were kept in the required position with cello-tape. Surgeons' staff wore a rubber lead apron of 0.5 mm lead equivalent as protection from scattered radiation. No lead rubber cola worn during all procedures. At each department, a single operating team was chosen to perform all the procedures, in order to avoid inter operator variations could result from the different skills and experiences of the orthopedists.

RESULTS AND DISCUSSION

The mean fluoroscopic exposure factors for aforementioned procedures were 72.4 kVp ±13, 1.4 mA±0.6 and 0.79 ±0.1 mins, while the mean radiation dose for the hands of orthopedist was 0.27 ±0.09 mGy per procedures.

The highest radiation dose to orthopedist hand resulted from DHS procedure, this can be attributed to complication of this procedure therefore orthopedists advised to be away from the primary beam as possible.

Madan *et al.* [6] stated that the hands of the surgeon were most likely to be directly exposed to ionizing radiation during intraoperative fluoroscopic screening in the case of bad practice. The study performed by Goldstone *et al.* [7] in the United Kingdom for surgeons within 44 procedures with similar dosimeter, reported that the total radiation dose received to the hands per surgeon ranged from 0.048 – 2.3 mSv. Similarly Muller *et al.* [8] evaluated the radiation dose to the hands during 41 procedures of intramedullary nailing of femoral and tibial fractures, revealed that the average dose of radiation to the dominant hand of the primary surgeon is 1.27 mSv and 1.19mSv to the first assistant, in comparison to this study the mean radiation dose showed lower value during the same procedures around 0.29 mSv.

Levin *et al.* [9] also used TLD rings to study the radiation dose to the orthopaedic surgeon during 30 close interlocking intramedullary nailing procedures. They reported an average of 0.23 mSv to the orthopaedic surgeon hands of exposure during insertion of the intramedullary nail and proximal locking screw, therefore this study showed slightly the same value in comparison to this study.

Osman *et al.* [10] reviewed the radiation dose for orthopedist hands; they reported that most studies used TLDs and also the most exposed organ is the orthopedist hands.

The present study was performed during one month in the aforementioned centers, the accumulative radiation dose averaged over the three centers was 14.3 mSv, therefore if the workload was the same in other months of the year, this would result in total accumulative radiation dose per year to the orthopedist's hand of 171.6 mSv which is below than annual dose limit 500 mSv for extremity that retained in the recommendations of the international commission on radiation protection [11].

CONCLUSION

The radiation dose depend on the workload of the orthopedist and fluoroscopic time encountered, Well training, continuous monitoring and rich knowledge about hazard among orthopedists are starting steps to reduce radiation risk. In spite of fact that local practice showed less radiation dose than published data, more optimization is needed.

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