



The need to protect the thyroid gland during image intensifier use in orthopaedic procedures

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The image intensifier has become an essential part of the orthopaedic surgeon's armamentarium. Its increasing use, however, may expose medical staff and theatre personnel to high doses of radiation. The aim of this study was to assess the compliance of surgeons and staff with radiation protection protocols, especially the use of the thyroid shield and to calculate the radiation exposure dose during routine orthopaedic procedures. We carried out this prospective study of 44 consecutive cases at the Rochdale Infirmary. The total dose of radiation and the total number of images taken were found to be more during hip surgery such as dynamic hip screw fixation for intertrochanteric fracture (1,715.5 mGy.cm²) and the intramedullary nailing (4,357.5 mGy.cm²). However the total percentage of the theatre personnel wearing thyroid shield was as low as 4% (14 people out of total 345 people present in theatre in 44 procedures) in spite of its availability.

The consistent neglect in the use of the thyroid shield by surgeons and nursing staff present in theatre during fluoroscopically assisted procedures is a matter for concern. The data presented in this study will emphasise the need to wear a thyroid collar during orthopaedic procedures and the need for better guidelines to protect theatre personnel as well as patients from radiation exposure hazards.

INTRODUCTION

With advancing technology and its application to medical science, current medical practice has been

revolutionised. Many orthopaedic procedures have become simpler, easier and less time consuming with the use of the image intensifier in the last few decades. In recent years, the use of fluoroscopic screening in orthopaedic surgery has increased because of the rising frequency of procedures such as dynamic hip screw fixation, intramedullary nail fixation and pedicle screw insertion. In a busy trauma department, the number of patients who are treated with fluoroscopic assistance may result in high radiation levels for the surgeon, the patient himself and the operating-theatre staff. Occupational radiation exposure and associated radiogenic risks to the orthopaedic surgeon and assisting staff are of increasing interest and importance (1-3, 9).

Previous studies have investigated the radiation exposure in theatre during orthopaedic surgeries (2, 3, 8, 10-12). The purposes of the present study

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were (1) to calculate the total radiation exposure dose during routine fluoroscopically guided procedures in orthopaedic surgery (9), to estimate the risk to certain body areas especially the thyroid which is not routinely covered by the lead gown (3), to identify the orthopaedic procedures requiring a higher number of fluoroscopic images and hence causing more radiation exposure (2), to increase awareness about radiation protection.

MATERIALS AND METHODS

The study was carried out at the Rochdale Infirmary, Manchester. It was a prospective study of 44 consecutive cases where various trauma procedures were performed using an image intensifier. The pro-forma prepared for the study recorded various factors including the total dose of radiation, the total duration of radiation and the total number of images taken during each procedure. The age and sex of the patient was noted along with the total number of theatre personnel using the lead gown and the thyroid shield. The study also included the grade of the surgeon, to find out whether experience of the surgeon could reduce the radiation exposure (2). The radiation measurements were obtained from the mobile C-arm fluoroscope unit (Siemens) which calculated the total number of images, the total dose and the duration of the procedure. The radiation unit was measured in mGray on the C-arm unit and converted to mSv (milliSievert) for the purpose of the study.

RESULTS

The commonest type of injury that required the use of the image intensifier was fracture of the neck of the femur requiring dynamic hip screw fixation (42%). The second commonest injury was manipulation of the fractures in young children, especially of the forearm bones (26%) and supra-condylar fractures of the humerus (10%) (fig 1). The maximum numbers of images were taken during intramedullary nailing (mean 66) and dynamic hip screw fixation surgery (mean 46). An average of 22 images was used during manipulation of fractures of the humerus and 17 for the forearm bones fracture. The total dose of radiation varied from average 4,357.5 mGy.cm² (milliGray.cm²) in intramedullary nailing surgery to 1.8 mGy.cm² for metacarpal fracture surgery (fig 2).

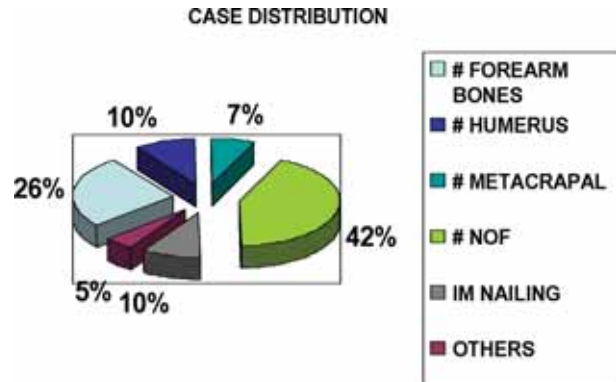


Fig. 1. — The commonest injuries that required the use of image intensifier.

The interesting finding that was revealed from the study was that, in spite of the high number (20) of images taken during metacarpal surgery including closed manipulations with Kirschner wiring, the average total dose of radiation for the procedure was negligible (1.8 mGy.cm²) as compared to that during DHS surgery and intramedullary nailing. The total duration of surgery was also the maximum during the intramedullary nailing (130 minutes) and DHS surgery (53 minutes). It was not as high as this in other procedures (table I). The other orthopaedic procedure requiring a high number of images was closed reduction and manipulation of fractures, the average being 17 for forearm bones manipulation and 22 for supracondylar fractures of the humerus.

During these 44 procedures, the total number of people present in theatre was 345 (average : 7-8 ; range : 5 to 10). Of these 345 people, 334 were wearing the lead gown (96.8%) but only 14 were wearing the thyroid shield (4%) in spite of its availability.

DISCUSSION

The present study was performed in an attempt to promote radiation protection awareness and the safe use of fluoroscopy in the trauma theatre. This study will encourage further studies on occupational hazards of radiation and allow for the accurate assessment of effective dose to the sensitive tissues

RADIATION EXPOSURE DURING ORTHOPAEDIC PROCEDURES

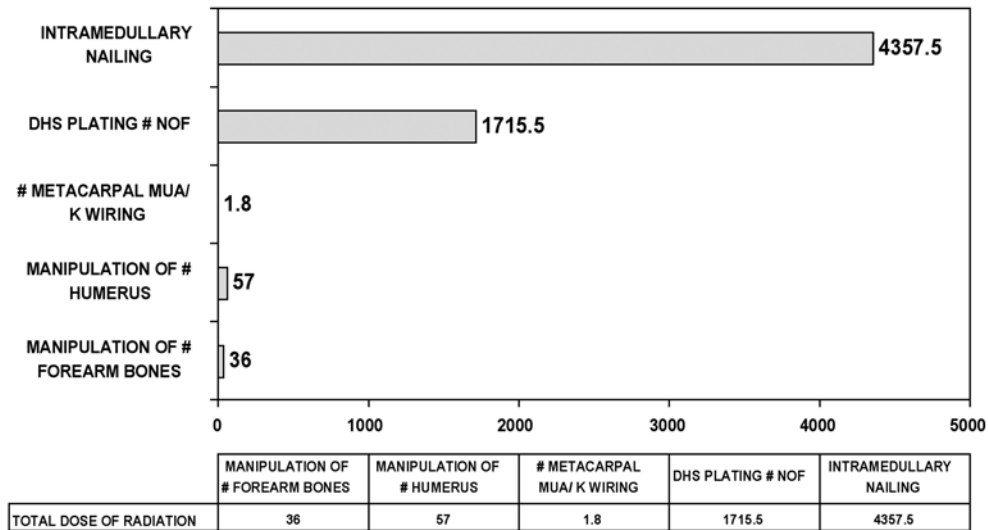


Fig. 2. — Radiation exposure measured in mGy.cm² on the image intensifier during various orthopaedic procedures (NOF = neck of femur ; MUA = manipulation under anaesthetic).

such as thyroid. It will also stress the need for radiation protection of the orthopaedic theatre staff by effective use of aprons and barriers such as thyroid shield.

The radiation sensitivity of a tissue is proportional to the rate of proliferation of its cells and inversely proportional to the degree of cell differentiation. Biological effects are greatest with rapidly growing tissues such as epithelium, bone, blood, gonads, thyroid and fetus. Some effects are cumulative. Studies of people exposed to high doses of radiation have shown that there is a risk of cancer induction associated with high doses. The specific types of cancers associated with radiation exposure include leukemia, multiple myeloma, breast cancer, thyroid cancer, lung cancer, and skin cancer. Radiation-induced cancers may take 10-15 years or more to appear. There may be a risk of cancer at low doses as well (4, 10, 12, 13).

Radiation Effects to Thyroid

Exposure to radiation over many years promotes the development of thyroid carcinoma (2). One hun-

dred mSv is the minimum dose reported that can cause thyroid carcinoma induction. Eighty five percent of the papillary carcinomas of the thyroid are radiation induced carcinomas. Although the lead gown is routinely worn as a part of most orthopaedic procedures, it does not cover the neck area and hence the thyroid tissue. In spite of its availability, most theatre personnel do not routinely use the thyroid shield during these surgeries. In our study only 14 people out of total 345 were using the thyroid collar during fluoroscopic exposure. The thyroid apron can decrease the amount of effective dose by 2.5 fold and there is almost 50% reduction in total exposure when it is used.

During any orthopaedic procedure, the theatre staff is exposed to three types of radiation, the primary radiation coming from the x-ray tube, the secondary or "scatter radiation" which is the radiation reflected off the patient and the operating table and the background radiation originating from the surrounding normal objects. It is the scattered radiation that the theatre staff is most exposed to. The x-rays travel in a straight line from their source of origin and get scattered in their travel path. Also the

Table I. — Average number of images and total dose of radiation during each procedure

Orthopaedic procedures	Duration of procedures	Average number of images taken	Total radiation dose
Manipulation of # forearm bones	18 minutes	17	36 mGy.cm ²
Manipulation of # humerus	22.5 minutes	22	57 mGy.cm ²
Metacarpal K wiring/MUA	10 minutes	20	1.8 mGy.cm ²
DHS plating for # neck of femur	53 minutes	46	1715.5 mGy.cm ²
Intramedullary nailing	130 minutes	66	4357.5 mGy.cm ²

beam intensity decreases as its distance increases from the tube. Accordingly, the ALARA principle (As Low As Reasonable Achievable) has laid down three guidelines for the staff radiation protection (5-7). It states that the staff should position themselves out of the primary beam and the minimum distance between the X-ray source and the staff should be six feet (1-3, 8, 9). These two objects are practically unachievable in the operating theatre as the surgeon and the assistant have to position themselves very close to the fluoroscopic unit. Hence the third consideration becomes more important for radiation protection and that is the use of effective shields or barriers to prevent radiation exposure.

CONCLUSION

The levels of occupational radiation exposure vary considerably with the type of fluoroscopically assisted procedure. The effective dose of radiation was significantly lower when the procedures involved imaging the superficial areas of the body. The study revealed that certain trauma procedures such as dynamic hip screw fixation for fracture of the neck of the femur, intramedullary nailing and closed manipulations of forearm and leg bones routinely require extensive use of fluoroscopic images. The total dose of radiation used during DHS surgery was almost 10 fold higher than the dose that can induce thyroid carcinoma. The thyroid is one of the sensitive tissues that are not routinely protected by the lead gowns routinely used during most trauma procedures. The strict inclusion of the thyroid shield as a part of routine radiation protection is recommended. We would also like to make people aware of the higher doses of radiation when using fluoroscopy to assist in surgery involving deep structures.

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