

Original Research Article

Knowledge and awareness of orthopaedic surgeons about radiation hazards in operation theatres

Manik Sehgal^{1*}, Bhanu Awasthi², Saloni Sood³, Sunil Raina⁴, Rubinder Kaur⁵, Sarvesh Singh¹, Punit Katoch⁶

¹Department of Orthopaedics, Pt. Jawahar Lal Nehru Government Medical College Chamba, Himachal Pradesh, India

²Department of orthopaedics, Dr. R. P. G. M. C Kangra at Tanda, Himachal Pradesh, India

³Department of Anesthesia, Pt. Jawahar Lal Nehru Government Medical College, Himachal Pradesh, India

⁴Department of PSM, Dr. R. P. G. M. C Kangra at Tanda, Himachal Pradesh, India

⁵PG Student Anesthesia, Sgrdimr, Amritsar, Punjab, India

⁶Department of orthopaedics, SLBSGMCH, Mandi, Himachal Pradesh, India

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*Correspondence:

Dr. Manik Sehgal,

E-mail: Maniksehgal2001@gmail.com

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ABSTRACT

Background: Due to increase in geriatric orthopaedic patients minimally invasive soft tissue and orthopaedic surgeries are gaining. But such procedures have increased the surgeon's dependence on fluoroscopy which has exposed them to ever increasing dosage of ionising radiations (both direct and scattered).

Methods: The study was carried out among medical professionals attending annual north zone conference of orthopaedics using a pre-designed questionnaire on a non-probability sample of 200 orthopaedicians. Questionnaires contained 11 MCQs.

Results: 62% of the surgeons believed that hands receive maximum amount of C-arm radiations followed by thyroid (25%). 9% of surgeons have answered eyes and 4% say gonads. 31% of surgeons believe that 100 mSv is allowable annual effective whole-body dose of radiation. 15% believe it to be 500 msv. Majority (37%) of the surgeons had no idea on the allowable annual effective whole-body dose of radiation. 30% of surgeons believe that allowable annual effective dose of radiation for hands is 50 msv. Further 23% of the surgeons believe it to be 100 msv. 50% have no idea about this.

Conclusions: All orthopaedic residents and surgeons should have more information and knowledge about ionising radiation. Special courses and workshops can be arranged at local, regional and national levels in this regard.

Keywords: Knowledge, Awareness, Orthopaedic surgeons, Radiation hazards

INTRODUCTION

Due to increase in technology awareness, and also due to increase in geriatric orthopaedic patients minimally invasive soft tissue and orthopaedic surgeries are gaining importance in order to reduce morbidity and minimise soft tissue damage. But such procedures have increased the surgeons dependence on fluoroscopy which exposes them to ever increasing dosage of ionising radiations (both direct and scattered). Indirect visualization of anatomy is

one of the fundamental requirements in varied orthopaedic approaches as in trauma, reconstructive and paediatric surgery. The harmful effects of radiation on the body are well known.

Besides that, low dose radiation exposure may have a cumulative effect on the body. Since the introduction of mini C-arm devices, fluoroscopic imaging is now routinely used in treating fractures in the emergency room and for outpatient and surgical orthopaedic procedures.¹ The indiscriminate use of fluoroscopic equipment by

orthopaedic surgeons (like, direct handling of the tube, placing hands directly in the field during operation of the machine) clearly breaches radiation safety guidelines.²

The International Commission on Radiological Protection has established the standards for radiation protection including the dosage limits.³ The maximum annual permissible upper dose limit is 20 mSv for the body, 150 mSv for thyroid or eyes, and 500 mSv for hands (International guidelines, ICRP). However, the dose limit for non-classified staff (for example, orthopaedic surgeons) is only 30% of these limits (that is, 150 mSv for hands).⁴ The recommended occupational dose of radiation for medical staff in Germany is 500 mSv for hands, 150 mSv for eyes and 300 mSv for thyroid.⁵

Reports indicate that among the procedures that require fluoroscopic monitoring, closed locked femoral nailing is responsible for a high level of scattered radiation exposure among primary surgeons.⁶ Five cancer cases over 7 years were reported in a small orthopaedic hospital (Villa Igea, Trento, Italy) in radiation-exposed workers. In that hospital, until August 1999, the use of radiation protective measures during intra-operative fluoroscopy was discontinuous, and 60% of the total post-operative radiographs were performed in a corridor in front of the operating rooms where, usually, the personnel used to take off their heavy and uncomfortable lead apron and dosimeter.⁷

Orthopaedic surgeons face a greater risk of radiation exposure to hand than radiologists and cardiologists.⁸ A study by Khan et al, assessing the awareness and attitudes of basic surgical trainees from England and Wales regarding ionizing radiation in orthopaedic trauma surgery, showed that they were lacking in the essential knowledge of ionizing radiation in orthopaedic trauma surgery. Most of them had never read the literature about it.⁹

Most of the surgical trainees did not wear the thyroid shield, and some of them were even unaware of it. Most of the trainees did not know the difference between scattered and direct radiation. The same scenario could be happening in the Indian orthopaedic departments. It was this concern that prompted us to assess knowledge and awareness of orthopaedic surgeons about radiation hazards in operation theatres.

METHODS

The study was carried out among medical professionals attending annual north zone conference of orthopaedics using a pre-designed questionnaire.

Questionnaire development

Initial work-up

An expert group comprising of two orthopaedic surgeons, two public health specialists and one statistician from

Himachal Pradesh developed a common questionnaire to be asked from orthopaedic surgeons attending a conference to know about their awareness and the practices they follow in their hospitals/institutions to protect them and their staff from radiation exposure. An effort was made to arrive at consensus in development of the questionnaire and questions were accepted for inclusion, if all the expert group members gave their consent.

Pre-pilot and questionnaire layout

The pre-pilot work centred on information-gathering on the suitability of the questionnaire developed. For this purpose, we sat down with 25 orthopaedic surgeons including residents and consultants and went through the questions together to identify problems they are facing in implementing proper safety measures to C-arm exposure and also regarding their awareness about its potential hazards. After a pre-piloting session, we amended the questionnaire before piloting with another group of 25 testers. The amended version was again based on a unanimous decision by the expert group. This process was aimed at arriving at such a questionnaire wherein questions were unambiguous, appropriate and acceptable to respondents and they can respond without any hesitation. Rehearsal survey was done on staff of the department of orthopaedics to look out for any problems, errors, doubts if any.

Pilot phase

After the appropriate modifications were made to the questionnaire self-designed and semi-structured questionnaire was created to capture flexibility of data. The questionnaire was validated and the reliability analysis attained with Cronbach's Alpha value of >0.70.

Data collection

Data was collected during the annual national level orthopaedic conference in the year 2017. This survey was targeted on orthopaedic community, specifically orthopaedic surgeons. A non-probability sample of 200 orthopaedicians attending the conference was included for the purpose of this study. Questionnaires containing 13 MCQ type questions were successfully distributed among the selected participants (Table 1). As the focus of this study was assessment of awareness about radiation hazards in operation theatres, no questions on regulations on diagnostic radiology, e.g. atomic energy (radiation protection) rules, 2004, were included. This point has been included in the revision.

General information regarding the survey, its aims and objectives were dictated to the participants from the stage of this annual trauma meet. Help booth was set up in the conference hall itself to sort out the queries of participants if any. Participation was purely voluntarily and participants need not to write their names and email id on the questionnaires in order to get the accurate and unbiased

responses. Respondents were required to fill up the survey forms and forms were collected at the end of the conference.

RESULTS

Total 62% of the surgeons believed that hands receive maximum amount of c arm radiations follow by thyroid (25%). 9 % of surgeons have answered eyes and 4% says genitals. 31% of surgeons believe that 100 mSv is allowable annual effective whole-body dose of radiation. 15% believe it to be 500 mSv. Majority (37%) had no idea. Rest 24% believe it to be 200 mSv. 30% of surgeons believe that allowable annual effective dose of radiation for hands is 50 msv.23% believe it to be 100 mSv. 50% have no idea. 11% said it to be 5 mSv. 79% of doctors believe that scattered radiation is the major source of radiation that effect the operating room personnel while 21% believe it's radiation beam from source. 41% of surgeons believe that radiation exposure is inversely proportion to square of distance between surgeon and source. 37% believe it's simple inverse to the distance. 11% believe it's inversely related to fourth power of the distance. The rest 11% don't know. 43% of surgeons believe that 120 cm is the critical distance beyond which radiation don't effect the operating surgeon/staff while

34% believe it to be 90 cm. 1% of surgeons believe it to be 30 cm and the rest 11% did not know. Further, 30% of surgeons believe that hand Surgery involves maximum exposure to surgeon while another 30% believe it to be the dosrolumbar spine. 29% surgeons choose pelvis Surgery and rest 1% did not know.

30% surgeons choose 1 mm of lead equivalent to be used in protective gear. 39% consider it to be 0.5 mm and 19% said it to be 0.7 mm. 12% doesn't know. 73% of surgeons always used the lead apron while working on C-arm. 23% use almost always. 3% uses sometimes and 3% usually used lead apron. 29% surgeons never used lead collar while using C-arm, 24% use it sometimes, 14% always use and 11% always almost use. 11% says they have almost never used lead collar. 81% of surgeons never used lead goggles while working on C-arm. Percentage use sometimes, 10% says almost never. 86% of surgeons have never used lead gloves while working under C-arm. 6% use sometimes. 6% have almost never used. 1% use usually. 44% believe first assistant is most commonly affected by radiation in operating room while 43% believe it's operating surgeon. 3% equally believe it to be scrub nurse and anaesthetist and 10% don't know. Only 30% surgeons have got their C-arm calibrated.

Table 1: Questionnaire used for the purpose of the study.

S. no.	Questionnaire
1.	Which party of orthopaedic surgeon body receives maximum amount of radiation from C-arm?
a.	Eyes
b.	Hands
c.	Thyroid
d.	Genitals
e.	Don't know
2.	What is the allowable annual effective whole-body dose of radiation?
a.	5 mSv
b.	50 mSv
c.	100 mSv
d.	500 mSv
e.	Don't know
3.	What is the main source of radiation that affects the operation room personnel?
a.	Radiation beam from source
b.	Scattered radiation
c.	Don't know
4.	What is the relationship between the radiation received by the surgeon and distance from the source?
a.	Inversely proportional to distance
b.	Inversely proportional to square of distance
c.	Inversely proportional to fourth power of distance
d.	Don't know
5.	What is approximate critical distance beyond which no significant radiation affect surgeon/staff?
a.	30 m
b.	60 m
c.	90 m
d.	120 cm
e.	Don't know
6.	Which of following regions when operated under image involve maximum exposure to surgeon?

Continued.

S. no.	Questionnaire
a.	Cervical spine
b.	Dorsolumbar spine
c.	Pelvis
d.	Hand
e.	Don't know
7.	What is the recommended lead equivalent to be used in protective gear?
a.	0.3 mm
b.	0.4 mm
c.	0.7 mm
d.	1 mm
e.	Don't know
8.	How frequently you use lead apron while using C-arm?
a.	Always
b.	Almost always
c.	Usually
d.	Sometimes
e.	Almost never
f.	Never
9.	How frequently you use lead collar while using c arm?
a.	Always
b.	Almost always
c.	Usually
d.	Sometimes
e.	Almost never
f.	Never
10.	How frequently you use lead goggles while using c arm?
a.	Always
b.	Almost always
c.	Usually
d.	Sometimes
e.	Almost never
f.	Never
11.	How frequently you use lead gloves while using c arm?
a.	Always
b.	Almost always
c.	Usually
d.	Sometimes
e.	Almost never
f.	Never
12.	Who do u think is most affected by operating room radiation?
a.	Surgeon
b.	First assistant
c.	Scrub nurse
d.	Anaesthetist
e.	Don't know
13.	Have you ever got your C-arm calibrated?
a.	Yes
b.	No

DISCUSSION

Radiography was discovered way back by Wilhelm Roentge in 1895. Since then scientists have searched for ways to create faster and brighter X-ray images, and this led to the introduction of the fluoroscopy device. Although

it is superior to conventional X-ray in that results are obtained more quickly and the image is available on the screen during irradiation, the most significant disadvantage of fluoroscopy is that both the patient and surgeon are exposed to more radiation than with conventional X-rays. Fluoroscopy have long been an

important tool in operation theatre of any orthopaedic surgeon since decades. Harmful effect of radiation on human body is also known since ages. Various studies had documented deficiencies in knowledge among orthopaedic residents, consultants, paramedics and OT staff about their understanding of ionizing radiation or the use of equipment involved in the process. Orthopaedic surgeons are exposed to scatter radiation mostly, not direct radiation, during surgery. The harmful effects of radiation are minimized by the use of a lead apron and devices to protect the gonads and thyroid gland. Studies have shown that the use of proper protection reduces a doctor's radiation exposure by 90%.¹⁰

In this study, we investigated the knowledge levels of orthopaedic surgeons working in northern Indian about fluoroscopic imaging, its harmful effects and methods to protect from the harmful effects of ionising radiation as it is frequently used in orthopaedics. Although doctors' use of protection varied according to the type of operation, protective gloves (6%) were not used frequently, even though the surgeon's hands were most exposed to the radiation during surgery. Moreover, only a small percentage of surgeons in this study used protective eyewear (7%).

Exposure to high doses of radiation cannot be prevented when surgeons do not know how many doses or exposures are necessary to obtain sufficient images. Regarding awareness of the radiation exposure 35% of the participants have no idea on allowable annual effective dose of radiation. Only 30% of the orthopedicians, who participated in this study, got their C-arm calibrated.

Orthopaedic assistants should be educated about the use of fluoroscopy, appropriate dosage for different regions of the body, in order to eliminate this problem. Better training in fluoroscopy can reduce operation time, unnecessary overdosing of patients, and indirect radiation exposure for surgeons. The use of C-arm and radiation exposure is an important issue that can affect the lives of orthopaedic surgeons and not only their patients.

A study by Bahari et al showed significant reduction in radiation exposure with use of the thyroid shield.¹¹ Muller et al also showed that the average ionizing dose without thyroid shield was 70 times higher compared to that of the shielded group.¹² In our study only 14% of surgeons have always used thyroid shield. 24% use it sometimes and 29% have never used it. Tasbas et al observed that senior surgeon always stands at safe distance (>90 cm) whenever assistant surgeon places the patient in position for intraoperative imaging. Their study reported significantly higher radiation doses among the assistant surgeons.¹³ In our study, 43% of the residents thought that senior surgeons received higher levels of radiation exposure while 44% believe it to be first assistant. 77% residents believe the critical distance to be >90 cm in our study.

CONCLUSION

These findings suggest that surgeons need to be aware of the potential radiation risk in orthopaedics and that risk-taking behaviour needs to be addressed through promotion of safe work practices by their employing institutions. Devices and instruction manuals associated with the use of fluoroscopy have changed and evolved. Orthopaedic surgeon can more efficiently utilize fluoroscopy and protect themselves properly from radiation by following current developments and regularly obtaining up-to-date information. Based on the above facts, the authors recommend that all orthopaedic residents and surgeons should have more information and knowledge about ionising radiation. Special courses and workshops can be arranged at local, regional and national levels. These courses should be a part of induction training of all orthopaedic residents. This shall not only help in the professional competence of our orthopaedic residents, but shall make them safe surgeons as well.

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