

Original Research Article

Occupational radiation exposure among orthopaedic surgeons: assessment of awareness and practices and a need for health promotional approach

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ABSTRACT

Background: In medicine, radio-diagnosis and imaging is one of the vital tools used for the diagnostic purposes. In orthopaedic surgeries the use of intraoperative fluoroscopy with C-arm is no doubt a beneficial technology but it comes with the occupational hazard of radiation exposure. This study therefore evaluates the awareness and practices of orthopaedic surgeons regarding occupational radiation exposure and its risks and the association of level of awareness and practices with various factors.

Methods: A cross sectional study was conducted among orthopaedic surgeons using a pre-designed, pretested, semi-structured, self-administered questionnaire, disseminated online. Questions on awareness and practices of occupational radiation exposure and its risks were asked after obtaining consent. Data was analyzed using software statistical package for social sciences (SPSS) version 20 and a p value of <0.05 was considered to be statistically significant.

Results: 150 completed forms showed that though majority (63%) of the study participants had adequate knowledge about occupational radiation exposure, the level of practices was only 12%. A statistically significant association ($p < 0.001$) was found between years of experience and adequacy of knowledge and practices, regarding radiation exposure. Majority (91%) believed, adequate training and a health promotional approach could be beneficial.

Conclusions: This study highlights the fact that occupational radiation exposure is an issue to be dealt with importance and thus the awareness and practices also needs to improve A health promotional approach with stringent rules needs to be taken to ensure adequate awareness and adequate practice among the orthopaedic surgeons.

Keywords: Occupational radiation exposure, Awareness, Practices, Orthopaedic surgeons, C-arm fluoroscopy

INTRODUCTION

In medicine, radio-diagnosis and imaging is one of the vital tools used for the diagnostic purposes. In orthopaedics, the use of different imaging modalities such as radiography, computer tomography, magnetic resonance imaging, ultrasonography are common. In orthopaedic surgeries the use of intraoperative fluoroscopy with C-arm is no doubt a beneficial technology but it comes with the occupational

hazard of radiation exposure to not only the surgeon but also other OT personnel. The use of fluoroscopy has increased tremendously in field of orthopedics. The image intensifiers have enabled orthopaedic surgeons to become technically more proficient and decrease the morbidity of the patient by minimizing area of operative field and decreasing operative time.¹ A regular C-arm exposes the patient to approximately 1,200 to 4,000 mrem/min. The surgeon may receive exposure to the hands from the

primary beam and to the rest of the body from scatter. Recommended yearly limits of radiation are 5,000 mrem to the torso and 50,000 mrem to the hands.² Orthopaedic surgeons are not classified as radiation workers and therefore there is a higher neglect and need in this regard. The World Health Organization recognizes that excessive exposure to ionizing radiation increases the risk of harmful sequelae, such as cancer.³ There are only very few studies worldwide that assesses the awareness and practices of occupational exposure and no such study from India.⁴⁻⁶

Objectives

To assess the awareness and practices of orthopaedic surgeons regarding occupational radiation exposure and its risks. To estimate the association of level of awareness and practices of occupational radiation exposure with various factors

METHODS

Study design

The study design was cross sectional.

Study population

The study population included Orthopaedic surgeons (including postgraduate students pursuing the subject).

Study duration

The study was conducted from July to December 2019.

Study tool

A pre-designed, pretested, semi-structured, self-administered, questionnaire was used. The questionnaire was disseminated as an online form (using Google Forms) through emails and other online messenger services. Questions on awareness and practices of occupational radiation exposure, years of experience and exposure and its risks were framed after literature search and then asked in the form.^{1,4-6} Sixteen questions on awareness and ten questions on practices of occupational radiation exposure were framed. If there were more than 50% correct responses (i.e. eight or more for awareness, five or more for practices) they were grouped as having adequate awareness and adequately practicing regarding occupational radiation exposure. A compulsory question on consent for participation and a statement on anonymity was added at the beginning of the form to ensure consent from the participant. In case the participant did not answer the question or answered 'No' to the question the form did not proceed further.

Data management and analysis

Data was extracted through google form as a MS Excel sheet and analysed using software SPSS version 20. Chi

square test and Fishers Exact test were applied to find the associations. A p value of <0.05 was considered to be statistically significant.

RESULTS

Among all the disseminated forms a total of 183 forms were received, out of which 150 fully completed forms were included in the study.

Socio-demographic and other characteristics of the study participants

The mean \pm S.D age of the study population was 42 ± 16.8 years. Majority, 148 (98.6%) of the study participants were males, whereas only 2 (1.4%) were female respondents. Among the orthopaedic surgeons majority were consultants or private practitioners-70 (47%), 37 (25%) were Junior and Senior residents, Professors, Assistant Professors and Associate professors comprised of 27 (18%), 10 (7%) and 4 (3%) of the study population. Majority 100 (67%) of the respondents were attached to private institutions, while those working in government institutions were only 50 (33%). Over 102 (68%) participants, had over 10 years of experience as an orthopaedic surgeon and 48 (32%) had less than 10 years of experience. It was found that, 121 (80.7%) of the orthopaedic surgeons performed surgeries – more than three days per week and only 19 (19.3%) performed surgeries on less than three days per week. As high as 110 (73.3%) study participants responded that, they used C-arm fluoroscopy in fifty percent or more surgeries per week, whereas 19 (12.7%) claimed they required C-arm fluoroscopy in all the surgeries performed.

Level of awareness and level of practices regarding occupational radiation exposure among orthopaedic surgeons

On assessing the level of awareness, it was found that, 94 (63%) of the study participants had adequate level of awareness and 56 (37%) had inadequate level of awareness. In case of the level of practice it was seen that only 18 (12%) respondents were adequately practicing regarding occupational radiation exposure of intraoperative c-arm fluoroscopy (Figure 1).

Protective measures commonly used against intraoperative radiation exposure used by the surgeons (multiple responses)

Among those who were regularly using at least some form of protective gear 13 (8.7%) , lead apron was the most commonly used 12 (92.3%) used protective measure used against intraoperative radiation exposure used by the surgeons, this was followed by Thyroid protector 2 (15.4%). The use of Protective eyewear and gloves, gonad protectors were not reported by any of the respondents.

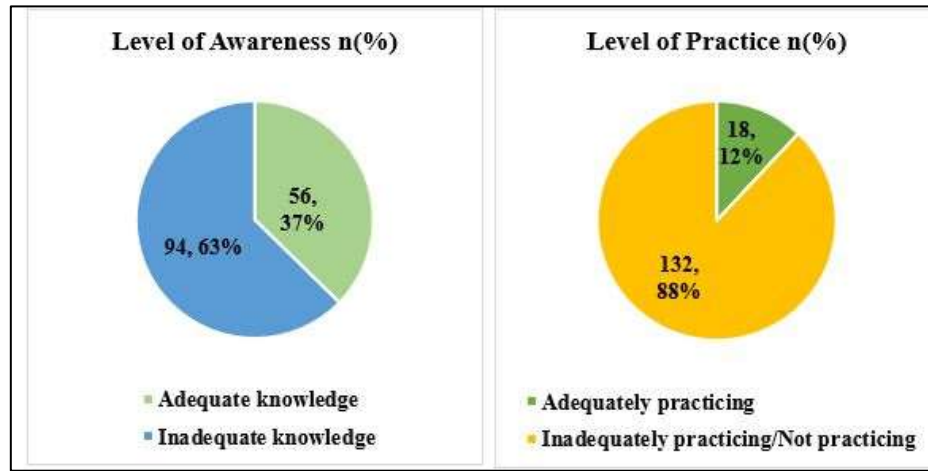


Figure 1: Adequacy of knowledge and practices regarding occupational radiation exposure among orthopaedic surgeons.

Table 1: Association of level of awareness and level of practice of occupational radiation exposure with years of experience (n=150).

Years of experience	Adequately aware (n= 94)	Inadequately aware/Not aware (n=56)	P value
More than 10 years (n=102)	73	29	0.0019
Less than 10 years (n= 48)	21	27	
Years of experience	Adequately practicing (n= 18)	Inadequately/Not practicing (n=132)	P value
More than 10 years (n=102)	3	99	0.0001
Less than 10 years (n= 48)	15	33	

Table 2: Some questions and responses on awareness and practices of Occupational radiation exposure used in the survey (n=150).

S. no.	Some questions regarding Occupational radiation exposure used in the survey	Positive or correct responses	
		Frequency	Percentages
1.	Have you read any literature on fluoroscopy?	21	14%
2.	Have you received any training on occupational radiation exposure?	13	8.7%
3.	Do you know how to operate the C arm machine?	50	33.3%
4.	What do you think is the recommended yearly limits of radiation exposure to the torso and to the hands?	89	59.3%
5.	Have you heard of ALARA principle?	78	52.0%
6.	Able to correctly explain the meaning of ALARA principle?	59	39.3%
7.	Able to correctly identify at least 3 of the basic methods of radiation dose reduction (9 options were provided- including correct and wrong)	23	15.3%
8.	Mention any major 2 health risks/effects of occupation radiation exposure	150	100%
9.	Do you regularly use at least some form of protective gear against intraoperative radiation regularly in every C-arm assisted surgery?	13	8.7%
10.	Use at least a lead Apron in every C-arm assisted surgery as a basic form of protection in every c-arm assisted surgery?	12	8.0%
11.	Do you use a radiation dosimeter?	4	2.7%
12.	Is the radiation safety of your operation theatre ever taken?	2	1.3%
13.	Are there warning signs on the door of the room where fluoroscopy is used?	9	6.0%
14.	Where do you stand during the fluoroscopy shooting while performing surgery?	10	6.7%

Reasons cited for not using protective measures (multiple responses)

The most common reason cited for not using protective measures was the feeling of being uncomfortable – 105 (70%), followed by not having adequate protective gears in operation theatres, cited by 85 (57%) surgeons.

Commonly experienced complaints during or post-surgery using C arm fluoroscopy (multiple responses)

Around 49 (33%) Orthopaedic surgeons said that they occasionally experience certain symptoms post or during surgery using C arm. The commonest complaints were - headache 25 (17%), eye pain 10 (7%), fatigue 10 (7%) and nausea 3 (2%). Around 101(67%) did not have any such post-surgery complaints.

Association of level of awareness and level of practice with years of experience

On assessing the association of level awareness and practices of occupational radiation exposure with years of experience, a highly significant association ($p < 0.001$) could be established. It was noted that even though orthopaedic surgeons with more than 10 years of experience had higher level of awareness as compared to those with less than 10 years of experience, their level of practice was significantly lower (Table 1). Age, designation, government or private sector employment, number of surgeries performed per week were not found to be significantly associated with level awareness and practices of occupational radiation exposure in our study.

Questions regarding occupational radiation exposure asked to the study participants

Some of the questions regarding occupational radiation exposure asked to the study participants are listed in table 2. As high as 87% of the study participants believed intra-operative radiation exposure of C-arm fluoroscopy is of a major concern among orthopaedic surgeons. Even though 33.3% of the participants knew how to operate a C-arm machine, the machine was operated by the OT technician or OT assistant in over 82% cases. Also, 65% of the study participants believed that making stringent rules about protective radiation gear for medical professionals will make a difference in Indian Context, whereas, 27% did not believe so and 8% of them were unsure about it. As high as 136 (91%) participants believed that if adequate training and health promotional approach is undertaken, this problem could be resolved.

DISCUSSION

The study was undertaken with the objective of assessing the awareness and practices of orthopedic surgeons regarding occupational radiation exposure and its risks and finding the association of level of awareness and practices with various factors. There is a huge paucity of study in

this regard among the orthopaedic surgeons. A few study on awareness and practices of occupational exposure were found internationally but none in India.⁴⁻⁶ Only study was found, which was conducted in India by Mahajan et al but its objective to analyse the amount of radiation received by orthopaedic surgeons in India using standard precautionary measures and also to bring awareness about the use of image intensifier safety in everyday practice.¹ Therefore, our study, though conducted among 150 orthopaedic surgeons, through an online survey was the only one of its kind.

The use of C-arm fluoroscopic imaging in the orthopaedic theatre is necessary but not without the risk of exposure to ionising radiation. In order to minimise the risk to the fluoroscopic operator and the operation theatre staff, adequate awareness pertaining and practices to radiation safety are required. Based on this study's findings, radiation safety awareness adequacy though 63%, the level of practice was seen to be only 12% among the respondents. This higher number in the level of knowledge component could also be attributed to the fact that this being an online survey could provide an opportunity for the participants to not be completely honest while filling up of forms and take use of the internet in finding the correct answer. Similar results were seen in other studies by Papendorp et al, Fidan et al and Tuncer et al.⁴⁻⁶

On finding the socio-demographic characteristics of the study population, mean \pm S.D age of the study population was found to be 42 ± 16.8 years. Majority, 148 (98.6%) of the study participants were males, whereas only 2 (1.4%) were female respondents. This could be attributed to the known larger male pre-dominance towards this specialisation in India. Among the orthopaedic surgeon's majority were consultants or private practitioners (47%), 25% were Junior and Senior residents, Professors, Assistant Professors and Associate professors comprised of 18%, 7% and 3% of the study population. Fidan et al reported in their study 46.7% were residents, 41.1% were specialist doctors, and 12.2% were associate professors and professors.⁵ They also reported 31.7% were working in university hospitals, 31.7% were in training and research hospitals 17.8% were in state hospitals and 18.8% were in private hospitals, while in our study majority 67% of the respondents were attached to private institutions, while those working in government institutions were only 33%.

On asking about years of experience, in our study, 68% participants, had over 10 years of experience as an orthopaedic surgeon. It was also found that 80.7% of the orthopaedic surgeons performed surgeries – more than three days per week, as high as 73.3% study participants responded that, they used C-arm fluoroscopy in fifty percent or more surgeries per week, whereas 12.7% claimed they required C-arm fluoroscopy in all the surgeries performed. Fidan et al reported that, 26.2% participants used fluoroscopy in 6-10 operations per week, 36.1% participants stated that they used fluoroscopy in 2-5 operations and 37.7% participants used more than in 10

operations per week.⁵ These differences could be attributed to the different profile of cases being operated in India as compared to other countries.

In our study, among those responding yes (8.7%) to be using at least some form of protection regularly in every c-arm assisted surgery, lead Apron was the most commonly used (92.3%) protective measure, this was followed by thyroid protector (15.4%) and the use of protective eyewear, gloves and gonad protector were reported by none. Even though, in our study the use of protective gears was much lower, lead apron use was the commonest. Similar responses of commonly using lead aprons, as a protective measure is reported in almost all other studies found.³⁻⁷

The respondents in our study reported, most common reason for not using protective measures was the feeling of being uncomfortable (70%), followed by not having adequate protective gears in operation theatres (57%). Similar results showing reasons indicated for not using certain radiation protection devices included discomfort and impracticality in a study by Van Papendorp et al.⁴

In a study by Tuncer et al 41% surgeons complained about only headache, had both headache and fatigue, 36% had no complaints after fluoroscopy use.⁶ In our study, it was found that 33% Orthopaedic surgeons occasionally experienced certain symptoms post or during surgery using C arm assisted surgery. The commonest complaints were-headache 17%, eye pain 7%, fatigue 7% and nausea 2% and around 67% did not have any such post-surgery complaints.

In our study, 8.7% reported that they had some form of prior training on radiation safety. A study by Van Papendorph reported, as high as 73% felt that they had not received adequate training on radiation safety.⁴

In our study though 33.3% participants reported that they knew how to operate a C-arm the machine was operated by the OT technician or OT assistant in over 82% cases. Tuncer et al reported higher percentage (97.4%) of the surgeons knew how to use fluoroscopy devices, even in their study majority (63%) took help from operating room personnel.^{1,6} Similar results were reported in other studies as well.^{4,5} In our study, only 2.7% said they used radiation dosimeter. Such low percentages were reported in the other studies as well.⁶

In our study 14% respondents said that they have read some literature regarding fluoroscopy, which was higher than Tuncer et al where, only 8.5% surgeons had read at least one article regarding fluoroscopy, they also reported, there was no relation between the participants' level of experience and this knowledge ($p>0.5$).⁶ In our study though, on assessing the association of level awareness and practices of occupational radiation exposure with years of experience, a highly significant association ($p<0.001$) could be established.

These results and the lack of awareness studies from India with regards to occupational radiation exposure further highlights the need for a health promotional approach to tackle this issue.

Limitations

This being a cross sectional study, causal association could not be established between various factors and the level of awareness and practices of occupational radiation exposure. The questions were disseminated as google forms through web-based application portals and emails, therefore the non-response rate and incomplete/ wrongly filled forms were high in number. Also, being an online survey, the responses on awareness could be biased (that is, the correct answers may have been searched for in online search engines etc.)

CONCLUSION

With the advancement of diagnostic and interventional technology the risk of radiation exposure has greatly increased. Studies have been conducted among radiologists regarding occupational radiation exposure but not among orthopaedic surgeons. There is not enough data regarding the radiation related cancers and other health implications of radiation exposure among orthopaedic surgeons. Reason being Orthopedic surgeons are not classified radiation workers therefore their risk and neglect is even higher. This study highlights the fact that though awareness about occupational radiation exposure was adequate in a good number of orthopaedic surgeons, their practices were inadequate. This further highlights the needs for a health promotional approach. Occupational radiational exposure among the orthopaedic surgeons being a highly neglected area demands further research to deal with the issue with greater importance.

Recommendations

The results of this study clearly highlights the need for a health promotional approach among the orthopaedic surgeons. Strategic guidelines regarding making stringent rules of occupational radiation exposure is needed even among surgeons specialized in streams that do not list them as radiation workers. The relevant associations and organizations must come forward as a team to propose the rules and regulations regarding occupational radiation exposure. Health promotional videos, lectures, adequate practice strategies should be recommended and promoted. Availability of protective equipment not only primary surgeons but all operation theatre personnel must be ensured. A specific fund designated for the purpose of acquiring enough protective equipment against intraoperative radiation exposure must be proposed to the government or relevant organizations. A health promotional approach is therefore the way forward in this regard.

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REFERENCES

1. Mahajan A. Occupational Radiation Exposure from C Arm Fluoroscopy During Common Orthopaedic Surgical Procedures and its Prevention. J Clin Diagnostic Res. 2015;1-4.
2. Singer G. Occupational radiation exposure to the surgeon. J Am Acad Orthop Surg. 2005;13(1):69-76.
3. Jenkins NW, Parrish JM, Sheha ED, Singh K. Intraoperative risks of radiation exposure for the surgeon and patient. Ann Transl Med. 2021;9(1):84-4.
4. van Papendorp LWA, Suleman FE, Hanekom H. The knowledge, awareness and practices of radiation safety amongst orthopaedic surgeons. South African J Radiol. 2020;24(1):1-5.
5. Fidan F, Çetin MÜ, Kazdal C, Kılıç F, Özkaya U. Behaviour and knowledge skill levels of orthopedic surgeons about radiation safety and fluoroscopy use: A survey analysis. Acta Orthop Traumatol Turc. 2019;53(4):301-5.
6. Tunçer N, Kuyucu E, Sayar Ş, Polat G, Erdil İ, Tuncay İ. Orthopedic surgeons' knowledge regarding risk of radiation exposition: a survey analysis. Sicot-J. 2017;3:29.
7. Kang S, Cha ES, Bang YJ. Radiation exposure and fluoroscopically-guided interventional procedures among orthopedic surgeons in South Korea. J Occup Med Toxicol. 2020;15(1):1-9.

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