

Knowledge and awareness of orthopaedic surgeons about radiation hazards in operation theatres- A cross sectional survey

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Abstract

Background: Though a routine nowadays, fluoroscopic use in the orthopaedic theatre setting is not without risk to the orthopaedic surgeon. Present study was conducted to know the knowledge of Orthopaedic surgeons about radiation safety and prevention.

Material & methods: The descriptive study was conducted in December 2020 with help of a web-based questionnaire formed in Google docs & sent to a random sample of 100 Orthopaedic surgeons from the sampling frame of active practitioners in various cities.

Results: In present study, out of 100 Orthopaedic surgeons, majority i.e., 88 (88%) said that surgeon is most affected by operating room radiation.

63 (63%) knew that hands receive maximum amount of radiation from C-arm, 13 (13%) said that thyroid receives maximum amount of radiation from C-arm.

79 (79%) knew the ALARA principle. 57 (57%) said that scattered radiation is the main source of radiation

that affects the operation room personnel, 41 (41%) said that radiation beam from source is the main source.

32 (32%) said that 30 m is the critical distance beyond which no significant radiation affects surgeon/staff, 19 (19%) said that 90 m is the critical distance.

36 (35%) said that 1 mm is the recommended lead equivalent to be used in protective gear, 15 (15%) said that 0.4 & 0.7mm is the recommended lead equivalent to be used.

82 (82%) said they were always using lead apron while using C-arm, 35 (35%) said they were using lead collar, 33 (33%) said they were using lead gloves, 25 (25%) said they were using thyroid shield. 49 (49%) said they were always using dosimeter.

52 (52%) told the reason for not using protective gadgets as heavy & uncomfortable, 16 (16%) said it is unavailable, 11 (11%) were unaware of gadgets while 21 (21%) had no reason of not using it.

Conclusion: The majority of orthopaedic surgeons regularly use fluoroscopic imaging in theatre, yet lack in-depth knowledge and awareness regarding radiation safety. Many reported of never using protective lead gadgets & dosimeter while using C-arm.

Keywords: Knowledge, Awareness, Orthopaedic surgeons, Radiation hazards

Introduction

The use of fluoroscopic imaging is increasing in the modern orthopaedic operation theatre. Advantages of intra-operative fluoroscopy include the indirect visualization of anatomy, enabling many orthopaedic procedures to be performed with greater ease, less time required. It causes less traumatization of patient tissues, thus reducing patient morbidity.¹

Placement of internal and external fixation devices, as well as long bone fracture reductions, are the orthopaedic procedures frequently performed under fluoroscopic guidance.²

Deterministic effects above a specific dose threshold include cataracts, alopecia, headache, dermal ulceration and infertility. Stochastic effects may include the induction of malignancy in radiosensitive organs like breasts, lungs, thyroid and red bone marrow.²

The thyroid, eyes, hands, and gonads are the most sensitive organs to radiation exposure. The eyes may exhibit the first effects of chronic radiation exposure as cataracts.³

85% of papillary carcinomas of the thyroid are probably radiation induced.⁴

A surgeon's hands have the greatest exposure risk to the radiation beam. So, the International Commission on Radiological Protection established the maximum annual dose limit as 20 mSv for the body, 150 mSv for the thyroid and eyes, and 500 mSv for the hands.⁵

The risk of exposure increases with the minimal invasive and complex procedures so adiation exposure remains a significant occupational hazard to the orthopaedic surgeon throughout their career.⁶

Since the introduction of mini-C-arm devices, fluoroscopic imaging is routinely used in treating fractures in the emergency room, for outpatient and surgical orthopaedic procedures.⁷

Sterile protective gloves do not offer as much protection as aprons or thyroid shields. Hands should not be placed directly in the beam when possible. The use of a Kocher forceps to aid with positioning may help reduce exposure of the hands when obtaining images. Gloves are not substitute for proper technique. Additional shields mounted on the table, ceiling, or on wheels should be utilized in the operating room if available.⁸

Whenever using fluoroscopy, it is important to remember the principle of (ALARA) 'As Low as Reasonably Achievable'. It is for the patient & for everyone in the operating room. Radiation exposure can be kept as low as reasonably achievable by:⁸

- Using personal protective equipment.
- Increasing surgeon's distance from the x-ray tube.
- Keeping hands out of the direct x-ray beam.
- Positioning of the image intensifier as close to the patient as possible.
- Using a collimator to decrease the size of the x-ray beam.
- Establishing effective communication with the radiology technician.

Scatter levels decrease proportionally to the inverse of the distance squared from the x-ray tube.⁸

Ionising radiation is both invisible and intangible is a hazard, difficult to stay aware of.⁹

A lead-equivalent thickness of at least 0.5 mm is typically required to protect 95% of scattered x-rays that strike it. Thyroid shields are usually included in commercially available lead aprons.¹⁰

Leaded eyewear can reduce the exposure to the eyes by 90% in pelvic and hip surgery.¹¹

Aims & Objectives

To assess orthopaedic surgeons’ knowledge, awareness and everyday practices regarding radiation safety.

Material & methods

The descriptive study was conducted in December 2020 with help of questionnaire formed in Google docs. The pre-tested. Web-based Questionnaire was sent to a random sample of 100 orthopaedic surgeons via mobile and emails. The sampling frame included all the active orthopaedic surgeons in various cities.

Inclusion criteria

Orthopaedic surgeons willing to participate in the study.

Exclusion criteria:

Orthopaedic surgeons not willing to participate in the study.

Table 1: Questionnaire

Who does u think is most affected by operating room radiation?
Which body part of orthopaedic surgeon receives maximum amount of radiation from C-am?
What is the main source of radiation that affects the operation room personnel?
What is the critical distance beyond which no significant radiation affects surgeon/staff?
What is the recommended lead equivalent to be used in protective gear?
How frequently you use lead & other protective gadgets while using C-arm?
Reason for not using protective gadgets

Data was collected. coded & analyzed using STATA version 10.1, 2011. Descriptive measures like % for the responses were estimated along with 95% Confidence Intervals (CI).

Results:

Table 2: Who do u think is the most affected by operating room radiation?

Who do u think is most affected by operating room radiation?	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)
Surgeon	88	88% (80.0 - 93.6%)
Assistant surgeon	10	10% (4.9 - 17.6%)
Scrub nurse	0	0%
Anaesthetist	2	2% (0.2 -7.0%)
Don't know	0	0%

In present study, out of 100 Orthopaedic surgeons, majority i.e.,88 (88%) (95%CI 80.0 -93.6%) said that surgeon is most affected by operating room radiation, 10 (10%) (95%CI 4.9 -17.6%) said that assistant surgeon is most affected by operating room radiation while 2 (2%) (95%CI 0.2 -7.0%) said that anaesthetist is most affected by operating room radiation. (Table 2)

Table 3: Which body part of orthopaedic surgeon receives maximum amount of radiation from C-am?

Which body part of orthopaedic surgeon receives maximum amount of radiation from C-am?	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)
Eyes	09	9% (4.2 -

		16.4%)
Hands	63	63% (52.8 - 72.4%)
Thyroid	13	13% (7.1 - 21.2%)
Genitals	09	9% (4.2 - 16.4%)
Don't know	06	6% (2.2-12.6%)

In present study, out of 100 Orthopaedic surgeons, majority i.e.,63 (63%) (95%CI 52.8 -72.4%) knew that hands receive maximum amount of radiation from C-am, 13 (13%) (95%CI 7.1 -21.2%) said that thyroid receives maximum amount of radiation from C-am, 9 (9%) (95%CI 4.2 -16.4%) said that eyes & genitals receive maximum amount of radiation from C-am each while 6 (6%) (95%CI 2.2-12.6%) didn't know which part of the body receives maximum amount of radiation from C-am. (Table 3)

Table 4: What is the main source of radiation that affects the operation room personnel?

Do you know ALARA principle?	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)
Yes	79	79% (69.7 - 86.5%)
No	21	21% (13.5 - 30.3%)
What is the main source of radiation that affects the operation room personnel?	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)

Radiation beam from source	41	41% (31.3 - 51.3%)
Scattered Radiation	57	57% (46.7 - 66.9%)
Don't know	2	2% (0.2 -7.0%)

In present study, out of 100 Orthopaedic surgeons, majority i.e.,79 (79%) (95%CI 69.7 -86.5%) knew the ALARA principle. 57 (57%) (95%CI 46.7 -66.9%) said that scattered radiation is the main source of radiation that affects the operation room personnel, 41 (41%) (95%CI 31.3 -51.3%) said that radiation beam from source is the main source while 3 (2%) (95%CI 0.2 - 7.0%) said they don't know the main source. (Table 4)

Table 5: What is the recommended lead equivalent to be used in protective gear?

What is the recommended lead equivalent to be used in protective gear?	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)
0.3 mm	10	10% (4.9 - 17.6%)
0.4 mm	15	15% (8.6 - 23.5%)
0.7 mm	15	15% (8.6 - 23.5%)
1 mm	35	35% (25.7 - 45.2%)
Don't know	05	5% (1.6 - 11.3%)

In present study, out of 100 Orthopaedic surgeons, majority i.e., 36 (35%) (95%CI 25.7 -45.2%) said that 1 mm is the recommended lead equivalent to be used in protective gear, 15 (15%) (95%CI 8.6 -23.5%) said that 0.4 & 0.7mm is the recommended lead equivalent to be

used, 10 (10%) (95%CI 4.9 -17.6%) said that 0.3 mm is the recommended lead equivalent to be used while 5 (5%) (95%CI 1.6 -11.3%) said they don't know the recommended lead equivalent to be used. (Table 5)

Table 6: How frequently you use lead gadgets & dosimeter while using C-arm?

How frequently you use lead gadgets & dosimeter while using C-arm?	Always (Percentage)	Sometimes (Percentage)	Never (Percentage & 95% CI)
Lead apron	82%	10%	08% (3.5 - 15.2%)
Lead collar	35%	03%	62% (51.7 - 71.5%)
Lead goggles	10%	02%	88% (80.0 - 93.6%)
Lead gloves	33%	03%	64% (53.8 - 73.4%)
Thyroid shield	25%	3%	72% (62.1 - 80.5%)
Dosimeter	49%	1%	50% (39.8 - 60.2%)

In present study, out of 100 Orthopaedic surgeons, majority i.e.,82 (82%) said they were always using lead apron while using C-arm, 35 (35%) said they were using lead collar, 33 (33%) said they were using lead gloves, 25 (25%) said they were using thyroid shield while 10 (10%) said they were using lead goggles.

49 (49%) said they were always using dosimeter to adjust the dose of radiation while using C-arm. (Table 6)

Table 7: Reason for not using protective gadgets

Reason for not using protective gadgets	No. of Orthopaedic surgeons (n=100)	Percentage (95% CI)
Unavailable	16	16% (9.4 - 24.7%)
Heavy & uncomfortable	52	52% (41.8 - 62.1%)
Lack of awareness	11	11% (5.6 - 18.8%)
No reason	21	21% (13.5 - 30.3%)

In present study, out of 100 Orthopaedic surgeons, majority i.e.,52 (52%) (95%CI 41.8 -62.1%) told the reason for not using protective gadgets as heavy & uncomfortable, 16 (16%) (95%CI 9.4 -24.7%) said it is unavailable, 11 (11%) (95%CI 5.6 -18.8%) were unaware of gadgets while 21 (21%) (95%CI 13.5 - 30.3%) had no reason of not using it. (Table 7)

Discussion

In present study, out of 100 Orthopaedic surgeons, majority i.e.,88 (88%) (95%CI 80.0 -93.6%) said that surgeon is most affected by operating room radiation. (Table 2)

Sehgal M et al found that 44% believe first assistant is most commonly affected by radiation in operating room. 43% believe it's operating surgeon. 3% equally believe it to be scrub nurse and anaesthetist. 10% don't know.¹²

In present study, out of 100 Orthopaedic surgeons, majority i.e.,63 (63%) (95%CI 52.8 -72.4%) knew that hands receive maximum amount of radiation from C-

am, 13 (13%) (95%CI 7.1 -21.2%) said that thyroid receives maximum amount of radiation from C-arm. (Table 3)

Sehgal M et al found that 62% of the surgeons said that hands receive maximum amount of c arm radiations.25% said thyroid. 9 % of surgeons said eyes. 4% said genitals.¹²

In present study, out of 100 Orthopaedic surgeons, majority i.e.,79 (79%) (95%CI 69.7 -86.5%) knew the ALARA principle. 57 (57%) (95%CI 46.7 -66.9%) said that scattered radiation is the main source of radiation that affects the operation room personnel, 41 (41%) (95%CI 31.3 -51.3%) said that radiation beam from source is the main source. (Table 4)

Nugent et al found that orthopaedic surgeons have inadequate knowledge concerning the use and risks of ionising radiation. They lack the necessary radioprotective knowledge for preventing damage caused by ionising radiation.¹³

Fidan F et al found that 106 participants (58.9%) were 1–2 steps away and 18 participants (10%) were 3 m away from fluoroscopy during the procedure; 56 participants (31,1%) were not careful about the distance from fluoroscopy.¹⁴

In present study, out of 100 Orthopaedic surgeons, majority i.e.,36 (35%) (95%CI 25.7 -45.2%) said that 1 mm is the recommended lead equivalent to be used in protective gear, 15 (15%) (95%CI 8.6 -23.5%) said that 0.4 & 0.7mm is the recommended lead equivalent to be used. (Table 5)

Mohammad M et al found that Physicians (p=0.006) ensure minimum 1-2 m distance from radiation source during the procedure. 78.6% technicians & 60% nurses follow this.¹⁵

In present study, out of 100 Orthopaedic surgeons, majority i.e.,82 (82%) said they were always using lead apron while using C-arm, 35 (35%) said they were using lead collar, 33 (33%) said they were using lead gloves, 25 (25%) said they were using thyroid shield. 49 (49%) said they were always using dosimeter to adjust the dose of radiation while using C-arm. (Table 6)

Hama B et al found that the protective gears were used by 75% (390) of the orthopaedic surgeons. 5% used it occasionally. A lead apron was used by all the orthopaedic surgeons. Only 25% used thyroid shield and 3% used protective eye gear additionally.¹⁶

Papendorp V et al found that 93% always made use of lead aprons. 11 (25%) participants always made use of thyroid shields. 2 (5%) participants only sometimes made use of lead aprons. 13 (30%) participants only sometimes made use of thyroid shields.¹⁷

In present study, out of 100 Orthopaedic surgeons, majority i.e.,52 (52%) (95%CI 41.8 -62.1%) told the reason for not using protective gadgets as heavy & uncomfortable, 16 (16%) (95%CI 9.4 -24.7%) said it is unavailable. (Table 7)

Papendorp V et al found that lead glasses, lead gloves, lead table skirts, and fixed and mobile lead shields were mostly not used due to unavailability. Other reasons included discomfort and impracticality. Rest was unaware that a particular device was meant for radiation protection.¹⁷

Conclusion

The majority of orthopaedic surgeons regularly use fluoroscopic imaging in theatre, yet lack in-depth knowledge and awareness regarding radiation safety. This while personal protective equipment is either unavailable or underutilised when present.

It can thus be recommended that a radiation safety and protection training programme be implemented.

A thorough understanding of radiation safety and knowledge of the ALARA principle can help the surgeon obtain quality images while decreasing the amount of harmful radiation exposure.

Limitations

- Small study population
- More elaborate studies are required
- The radiation hazard and long-term follow-up were not included.
- Not including a more widespread group of professionals (radiographers, medical physicists and radiation safety officers).

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