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Evaluation of Radiation Protection Practices in Fluoroscopy: A Comprehensive Study

[1]Mr. Rohit Bansal, [2]Mr.Sachin Chawla, [3*]Ms. Nivedita Swarnkar, [4]Ms. Archi, [5]Ms. Iqra Sajad, [6]Ms. Riya Singh

[1]Assistant Professor, Department of Radiology and Imaging Technology, Sanskriti University, Mathura, Uttar Pradesh, India (https://orcid.org/0009-0007-5648-0460)

[2]Assistant Professor, Department of Radiology and Imaging Technology, Om Sterling Global University, Hisar, Haryana, India

[3*]Assistant Professor, Department of Radiology and Imaging Technology, Shri Guru Ram Rai University, Dehradun, Uttrakhand, India

[4]Assistant Professor, Faculty of Paramedical and Allied Health Sciences, SKD University, Hanumangarh, Rajasthan, India

[5]Assistant Professor, Department of Radiology and Imaging Technology, Gulzar Group of Institute, Khanna, Punjab, India

[6]Assistant Professor, Department of Radiology, RIMT University, Mandi Gobindgarh, Punjab, India

Abstract: Fluoroscopy experts, constantly exposed to X-ray radiation, face an elevated risk of radiation-induced cancer. This study aimed to assess the safety measures employed by medical personnel, particularly those working in gastroenterology theaters, to mitigate the risks associated with prolonged radiation exposure.

The survey encompassed patients and medical professionals involved in fluoroscopic procedures. Observations were made on individuals, including patients, radiation technologists, radiologists, surgeons, and students, all wearing radiation protection clothing. A total of 30 patients and 17 medical professionals were observed during the study.

Fluoroscopy suites are equipped with various shields, such as table skirts, ceiling-suspended shielding, and mobile shields on wheels, designed to reduce scatter radiation from patients—a primary source of operator exposure. Essential radiation protection garments, such as leaded aprons and thyroid shields, are crucial for personnel in fluoroscopy settings, providing both comfort and adequate protection.

Observations on patients revealed that 49.80% used thyroid shields, 42.7% used gonad shields, 97.6% employed collimators to reduce scatter radiation, and 100% utilized filters. Surprisingly, lead aprons were not used on patients, as they would obstruct the target area.

Among medical professionals 63% of radiation technologists used lead gloves, all medical professionals wore lead aprons, 45% of surgeons used thyroid shielding, and none used lead goggles during the investigation.

In conclusion, the study found that all observed medical professionals demonstrated good work practices and possessed sufficient knowledge about radiation protection and protective apparel. However, the need for scheduled training on radiation protection devices and the effects of radiation on patients and personnel, mandated by various regulatory bodies, was emphasized.

Keywords: Lead Apron, Thyroid Shield, Lead Gloves, Tube Curtain, Collimator, Filters

I. INTRODUCTION

Fluoroscopy, a dynamic medical imaging technique, provides real-time visualization of internal organs and tissues on a computer screen through successive pulses of X-ray beams. Unlike static X-rays, fluoroscopy operates akin to a video, serving as a vital diagnostic tool and providing interventional guidance for procedures such as catheter placements and surgeries.

Historically, early fluoroscopes comprised a simple setup with an X-ray source and a fluorescent screen, where the patient was positioned. The remnant X-ray beam, after passing through the patient, produced a visible glow on the screen, observed directly by the practitioner. In contemporary systems, the fluorescent screen is linked to an electrical device, amplifying and converting light into a video signal suitable for electronic display. This advancement minimizes the fluoroscopist's proximity to the screen, reducing radiation exposure and lowering patient radiation doses.

Crucial to modern fluoroscopy equipment are shutters that restrict the geometric extent of the X-ray field, enhancing precision. Additionally, collimation, achieved through an iris-shaped lens, focuses and narrows the primary X-ray beam, minimizing patient tissue exposure to scattered radiation. The result is improved image quality and reduced scattered radiation exposure for healthcare workers.

Established in 1928, the International Commission on Radiation Protection (ICRP) plays a pivotal role in radiological safety, regularly issuing reports on various applications of ionizing radiation. Radiation exposure in fluoroscopy stems from three primary sources: the primary X-ray beam, leakage, and scattered X-ray beams. Stringent monitoring, essential for personal safety and regulatory compliance, is mandated by the Atomic Energy (Radiation Protection) Rules, 2004.

The paramount goal of radiation safety is to shield patients, staff, and the public from unnecessary exposure to ionizing radiation. Radiological safety, encompassing the science and practices of radiation protection, involves the use of protective devices and adherence to sound work practices. These protective devices include lead aprons, thyroid shields, gonad shields, lead gloves, tube curtains, collimators, filters, and ceiling-mounted barriers. Radiation professionals working in radiology rooms must consistently wear these protective devices, extending the same protection to patients when operating the X-ray tube.

Lead, with its high density and atomic number, stands as the preferred material for radiation-shielding devices. Highly effective in attenuating X-rays and gamma rays, lead serves as a critical component in safeguarding against the harmful effects of ionizing radiation on the human body, affecting molecules, cells, tissues, and organs.

II. AIM & OBJECTIVES

The primary aim of this study was to critically evaluate the adherence to radiation protection device practices in fluoroscopy, aligning with the guidelines set forth by regulatory authorities and international radiation safety standards. The overarching objective was to assess the proficiency of Radiology technicians, surgeons, and students in utilizing radiation protection devices, ensuring the safety of both patients and personnel within the Gastroenterology and Radiology procedure rooms.

Objectives:

1. Regulatory Compliance Assessment:
    - Evaluate the extent to which fluoroscopy practices align with the guidelines established by regulatory bodies governing radiation safety.
2. Knowledge Assessment of Radiology Technicians:
    - Assess the knowledge base of Radiology technicians regarding the proper utilization of radiation protection devices during fluoroscopic procedures.
3. Knowledge Assessment of Surgeons:
    - Examine the understanding and application of radiation protection measures among surgeons involved in fluoroscopic interventions.
4. Knowledge Assessment of Students:
    - Evaluate the awareness and proficiency of students, particularly those in the field of Radiology, regarding the use of radiation protection devices within the Gastroenterology and Radiology procedure rooms.

5. Safety Measures Implementation:
    - Analyze the practical implementation of safety measures by personnel, focusing on the correct usage of radiation protection devices during various stages of fluoroscopic procedures.
6. Identification of Gaps and Training Needs:
    - Identify any gaps or deficiencies in the knowledge and practices of Radiology technicians, surgeons, and students, with a view to determining specific areas that may require additional training or educational interventions.
7. Recommendations for Improvement:
    - Propose targeted recommendations and strategies aimed at enhancing radiation protection device practices, thereby fostering a safer environment for both patients and healthcare personnel in fluoroscopy settings.

III. METHOD

3.1 Study Design: Prospective study.

3.2 Study Area: The study was conducted in the gastroenterology department and radiology department of Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Ambala, Haryana.

3.3 Sampling Method: Random patient sampling formed the basis of data collection. Observations were made on patients and medical professionals in the gastroenterology and radiology departments at Maharishi Markandeshwar Hospital, Ambala, during various fluoroscopic procedures.

3.4 Type of Study: Observational prospective study.

3.5 Duration of Study: January 2022 to May 2023.

3.6 Sample Size: The study involved 480 individuals, including 370 patients and 110 medical professionals (radiology technologists, radiologists, surgeons, and students).

3.7 Inclusion Criteria:

- OPD (outpatients department) patients.
- Patients of different age groups.
- Adult patients capable of wearing protective devices.

3.8 Exclusion Criteria:

- Pregnant women.
- Patients with psychological illness.
- IPD (In patients department) patients.
- Pediatrics patients.
- Medico-legal cases.
- Recent trauma patients.
- Uncooperative patients.

3.9 Technique of Study: All patients referred for various studies (Barium swallow, Barium meal, Barium enema, Intravenous Pyelography, Retrograde Urethrography, Micturating cysto-urethrography, Hystero-salpingography, Endoscopic retrograde cholangiography, T Tube Cholangiography) were included in the data analysis. Radiation protection devices were provided to all patients during scans, and monitoring was done during and post-scanning.

All radiation technologists, radiologists, physicians, and students were monitored during procedures to assess the usage of radiation protection devices.

3.10 Materials:

Instrument Used: Fluoroscopy units - Allengers Medical System Limited fixed high-frequency fluoroscopic X-ray machines.

- MARS-50 (G-XR-20843)
- MARS-80 (G-XR-23274)

Specifications of MARS-50 and MARS-80:

- Model Name and Number: Allengers MARS-50 and MARS-80
- Equipment/Machine type: Fixed
- Machine Frequency: High
- Peak KiloVoltage (kVp): 125 kVp
- Tube type/Target: Rotating Anode
- Display type: Analog
- Equipment Current: Up to 1000mA
- AERB approved: Yes
- Operation mode: Manual
- Generator type: High frequency
- Technology type: Analog
- Country of origin: India
- Tube ratings: MARS-80: 80 KW and MARS-50: 50 KW

3.11 Data Analysis: Data was analyzed using descriptive statistical tools, including frequency, mean, and percentage. Chart tables in the Radio-diagnosis department at Maharishi Markandeshwar Hospital were utilized for data collection, covering patient age, sex, marital status, examination performed, and equipment used (e.g., lead apron, thyroid shield, gonad shield, lead gloves, filters, collimators). Monitoring during examinations focused on the use of radiation protective devices.

IV. DATA COLLECTION

The data collection process for this prospective study involved a physical visit to MAHARISHI MARKENDESHWAR HOSPITAL in AMBALA. The primary objective was to assess the awareness and knowledge regarding the use of radiation protection devices during fluoroscopy investigations among radiographic technologists, radiologists, and physicians. The study encompassed a total of 480 participants, including 370 patients and 110 medical professionals, consisting of 15 radiographic technologists, 35 radiologists/physicians, and 60 student interns.

The method of data collection was meticulous and organized, relying on a chart table that incorporated essential information. Parameters such as patient age, sex, specific examinations performed, and the utilization of various radiation protection devices (e.g., lead apron, thyroid shield, gonad shield, lead gloves, filters, and collimators) were systematically recorded. This comprehensive approach allowed for a thorough demographic profile analysis.

Furthermore, the study involved proactive engagement with all medical professionals, querying them about their understanding of radiation protection and assessing their knowledge in this regard. During fluoroscopic procedures, a vigilant monitoring process was implemented to ascertain whether patients, radiation technologists, radiologists/physicians, and students adhered to the usage of radiation protection devices. The resulting data was then meticulously organized into a chart table, facilitating subsequent analysis.

The demographic profile analysis focused on patients' characteristics, including age distribution, sex ratio, investigation types, and the prevalence of radiation protection device usage. Similarly, the analysis extended to medical professionals, encompassing age groups, sex ratios, and the consistent application of various radiation protection devices during investigations. This comprehensive data collection process served as a robust foundation for the subsequent stages of the study.

V. RESULT

The study's analysis reveals insights into the utilization of radiation protection measures among patients and various medical professionals involved in fluoroscopy procedures. For patients, the predominant age group was 26-35 years, with an equal gender distribution. Notably, 49.80% used thyroid shields, 42.70% used gonad shields, and 97.60% used collimators, showcasing a considerable awareness of protective measures. Filters were universally employed in all cases, but the use of lead aprons was not observed due to potential interference with the investigation area.

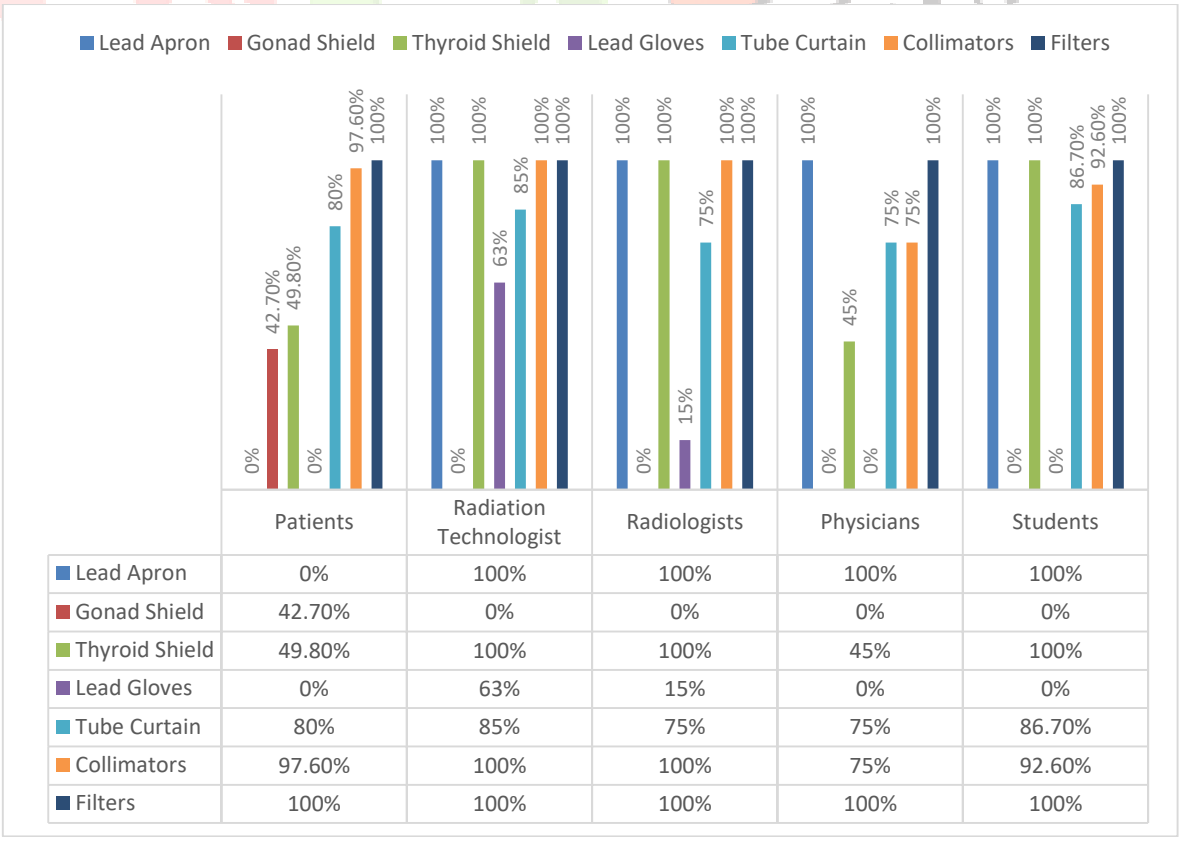
In the observation of medical professionals, the focus was on radiation technologists, radiologists, physicians, and internship students. Radiation technologists, predominantly aged 30-40 years (75%), displayed consistent use of lead aprons and thyroid shielding, with 85% using tube curtains in fluoroscopy machines. Collimators and filters were universally employed, while lead gloves and goggles were observed in 63% and 0% of cases, respectively.

Radiologists, with a balanced age distribution (50% each in the 20-30 and 30-40 age groups) and a 1:1 gender ratio, consistently utilized lead aprons and thyroid shielding, along with collimators and filters. However, lead goggles and lead gloves were not part of their observed practices.

Physicians, evenly split between the 20-30 and 30-40 age groups with a 3:1 male-to-female ratio, universally used lead aprons, with thyroid shields employed by 45%. Notably, lead gloves and lead goggles were not utilized by any physicians, and collimators and tube curtains were observed in 75% of cases.

Internship students, aged 20-30 years, with a majority being males (57%), demonstrated a high adherence to protective measures. All students consistently used lead aprons and thyroid shielding, while lead gloves and lead goggles were not observed. Around 86.70% used tube curtains, and approximately 92.60% used collimators during investigations.

This comprehensive analysis underscores the varying practices across different personnel categories, emphasizing the importance of ongoing awareness and adherence to radiation protection protocols in fluoroscopy procedures.



	Patients	Radiation Technologist	Radiologists	Physicians	Students
Lead Apron	0%	100%	100%	100%	100%
Gonad Shield	42.70%	0%	0%	0%	0%
Thyroid Shield	49.80%	100%	100%	45%	100%
Lead Gloves	0%	63%	15%	0%	0%
Tube Curtain	80%	85%	75%	75%	86.70%
Collimators	97.60%	100%	100%	75%	92.60%
Filters	100%	100%	100%	100%	100%

Graph: Graphical representation visually summarized these findings, depicting the varying degrees of radiation protection device utilization among medical professionals, providing valuable insights into the current practices in fluoroscopy safety.

VI. CONCLUSION

In recent years, the widespread use of ionizing radiation in medical imaging has substantially increased, posing an elevated risk of radiation exposure for both patients and healthcare professionals. Dental and medical X-rays have become primary man-made sources of radiation exposure, emphasizing the urgency of addressing radiation safety knowledge among various health worker cadres. The study conducted at Maharishi Markandeshwar University, specifically in the gastroenterology department of both Maharishi Markandeshwar Institute of Medical Sciences and Research and Maharishi Markandeshwar Super Specialty Hospital, focused on fluoroscopic procedures. The study encompassed patients, fluoroscopy operators (technologists), radiologists, physicians or surgeons, and internship students. Concerns highlighted the importance of radiation protection devices to minimize scatter radiation. Notably, 49.80% of patients used thyroid shielding, while 42.70% used gonad shields. Patient attendants also received proper radiation protection. Among medical professionals, all technologists used lead aprons, thyroid shields, and filters. Radiologists and physicians consistently utilized lead aprons, thyroid shields, tube curtains, and collimators during investigations. However, lead gloves and lead goggles were not universally used due to the nature of certain investigations. Students demonstrated good adherence to safety practices, with all wearing lead aprons and thyroid shields. The study emphasized the significance of employing radiation protection devices to mitigate risks, and overall, medical personnel at MMIMSR exhibited sound work habits and knowledge in radiation safety.

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