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## Original Article

### Evaluating Knowledge and Safety in Contrast Media Utilization Among Radiology Students and Technicians: A Cross-Sectional Survey

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#### ABSTRACT

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**Background:** Contrast media are essential in radiological imaging to improve diagnostic accuracy. However, insufficient knowledge and preparedness among radiology students and technicians may result in adverse events and compromise patient safety.

**Objective:** To evaluate the knowledge, preparedness, and safety practices regarding contrast media use among radiology students and technicians in a tertiary care teaching hospital.

**Methods:** A cross-sectional survey was conducted using a structured questionnaire comprising 20 questions. The questionnaire assessed demographic information, knowledge of contrast agents used in CT and MRI, consent-taking practices, emergency preparedness, training exposure, and awareness of adverse reactions. A total of 73 participants, including students, interns, and technicians, participated. Data were analyzed using descriptive statistics.

**Results:** While 75% of participants acknowledged the importance of contrast media in enhancing image quality, only 35% were confident in identifying symptoms of contrast-related reactions. Additionally, 47% had received formal training, and 89% expressed the need for simulation-based emergency preparedness workshops. Knowledge gaps were observed regarding types of contrast agents, precautionary protocols, and emergency management.

**Conclusion:** Although most participants recognized the role of contrast media in diagnostic imaging, significant deficiencies were noted in their knowledge and emergency preparedness. Structured training, regular workshops, and integration of contrast safety protocols into academic curricula are strongly recommended to enhance patient safety.

**Keywords:** Adverse Reactions, Contrast Media, CT Imaging, Radiology Students

## INTRODUCTION

Contrast media are integral to contemporary diagnostic imaging, substantially enhancing the visualization of anatomical structures and vascular systems. These agents are particularly crucial in modalities such as computed tomography (CT) and magnetic resonance imaging (MRI), where they facilitate the delineation of pathological conditions and improve diagnostic precision <sup>[1,2]</sup>. Nevertheless, the administration of contrast agents carries inherent risks. Adverse reactions may range from mild manifestations, such as nausea, to severe anaphylactic events, highlighting the necessity for comprehensive knowledge and preparedness among radiology personnel <sup>[3]</sup>. Additionally, recent studies have drawn attention to the risk of contrast-induced nephropathy (CIN), especially in patients with pre-existing renal dysfunction <sup>[4]</sup>. In the Indian context, research indicates variability in the awareness and implementation of contrast media safety measures among radiology students and technicians <sup>[5,6]</sup>. International

guidelines, including those from the American College of Radiology (ACR) and the European Society of Urogenital Radiology (ESUR), emphasize meticulous patient screening, obtaining informed consent, and readiness to manage emergencies [7,8]. Despite these recommendations, the real-time management of contrast reactions remains challenging, particularly in resource-constrained healthcare environments [9]. Prior Indian studies have advocated for the development of structured training programs and the integration of safety protocols into academic curricula [10,11]. Key areas where knowledge gaps persist include simulation-based emergency training, familiarity with crash carts, and the prompt administration of emergency medications such as epinephrine [12,13]. The present study was conducted to evaluate the level of awareness, preparedness, and adherence to safety practices regarding contrast media among radiology students, interns, and technicians. The objective is to identify knowledge deficiencies and propose strategies at the institutional level to enhance patient safety and emergency readiness [14,15].

## AIM AND OBJECTIVE

**Aim:** To assess the knowledge, preparedness, and safety practices related to contrast media administration among radiology students and technicians in a tertiary care teaching hospital and to identify areas requiring improvement through targeted training and reinforcement of safety protocols.

### Objectives

1. To assess the level of knowledge regarding types, indications, contraindications, and adverse reactions of contrast media among radiology students and technicians.
2. To evaluate preparedness for managing contrast-related emergencies, including familiarity with emergency drugs, crash cart components, and institutional protocols.
3. To examine current safety practices related to patient screening, informed consent, contrast administration, and post-procedure monitoring.

## MATERIALS AND METHODS

**Study Design:** This study employed a cross-sectional, questionnaire-based design to evaluate the knowledge, preparedness, and safety practices related to contrast media usage in radiological environments.

**Study Setting:** The survey was conducted at Maharishi Markandeshwar (Deemed to Be) University, Mullana, along with its affiliated healthcare institutions, MM Super Specialty Hospital, Mullana, and MM Hospital, Sadopur, Ambala, Haryana.

**Study Population and Sample Size:** The study

population comprised radiology students at undergraduate and postgraduate levels, interns, and radiology technicians. A total of 73 completed and valid responses were obtained during the data collection period.

**Sampling Technique:** A mixed sampling strategy was adopted. Purposive sampling was used to ensure participation from individuals with a radiology background, while convenience sampling facilitated accessibility and voluntary participation.

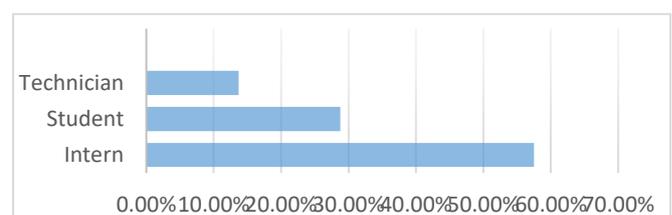
**Data Collection Tool:** Data were collected using a structured, anonymous questionnaire designed in Google Forms. The tool included 20 close-ended items covering key domains such as types of contrast agents, their applications in CT and MRI, identification of adverse reactions, levels of emergency preparedness, and previous training exposure.

**Data Collection Procedure:** The online survey was conducted from June 15 to July 15, 2025. The questionnaire link was disseminated through institutional platforms, academic forums, and departmental communication channels associated with radiology programs.

**Data Analysis:** All collected responses were exported to Microsoft Excel for analysis. Descriptive statistics, including frequencies and percentages, were used to evaluate participant demographics and assess knowledge, preparedness, and safety practices related to contrast media usage. The results are presented in structured tables to highlight key patterns and identify gaps relevant to training and emergency response among radiology personnel.

## RESULTS

A total of 73 participants completed the survey and were included in the final statistical analysis. Descriptive statistics were used to summarise demographic characteristics, knowledge levels, awareness of safety practices, and training status related to contrast media use. Among the respondents, 56.2% (n = 41) were female and 43.8% (n = 32) were male. With respect to professional status, the majority were radiology students (57.5%, n = 42), followed by radiology technicians (28.8%, n = 21) and interns (13.7%, n = 10), indicating a predominance of participants at the academic and early professional stages (Fig-1.)



**Fig-1. Demonstrating the Percentage of Participants**

Knowledge regarding contrast media usage across imaging modalities was generally high. A substantial proportion of participants (86.3%, n = 63) correctly identified MRI as the modality utilising gadolinium-based contrast agents. In the context of CT imaging, Iohexol was the most commonly recognised contrast agent (49.3%, n = 36), followed by Iopamidol (39.7%, n = 29), Iodixanol (23.3%, n = 17), and Barium sulfate (11.0%, n = 8) (Table 1). Awareness of patient-related risk factors for contrast-induced nephropathy (CIN) was moderate, with 74.0% (n = 54) of respondents correctly identifying pre-existing renal impairment as a major risk factor. Participants demonstrated variable awareness of adverse contrast reactions. Among mild reactions, nausea and vomiting were identified by 80.8% (n = 59), while a warm sensation was recognised by 57.5% (n = 42) of respondents. For severe reactions, respiratory distress was identified by 65.8% (n = 48), and hypotension by 42.5% (n = 31), indicating better recognition of common symptoms compared to less frequent but critical signs. Formal training in contrast reaction management was limited. Only 32.9% (n = 24) reported having received structured training, and 35.6% (n = 26) had completed hands-on emergency training. Additionally, 76.7% (n = 56) reported that they had never witnessed a contrast media reaction, suggesting restricted practical exposure.

Knowledge of emergency management protocols showed mixed results. Epinephrine administration as the first-line treatment for severe anaphylaxis was correctly identified by 72.6% (n = 53) of respondents. Awareness of the crash cart location was reported by 75.3% (n = 55); however, only 54.8% (n = 40) expressed confidence in assisting during a contrast-related emergency. Furthermore, 58.9% (n = 43) were aware of established classification systems for contrast reactions. Training inadequacies were further highlighted by the finding that 64.4% (n = 47) had never undergone practical training specifically related to contrast reaction handling. Perceptions regarding the diagnostic benefits of contrast media were overwhelmingly positive. A majority agreed that contrast media enhances vascular visualisation (82.2%, n = 60), improves overall image quality (75.3%, n = 55), and facilitates accurate diagnostic interpretation (69.9%, n = 51). Pre-procedural safety measures were well recognised, with 84.9% (n = 62) supporting the acquisition of a detailed patient history, 72.6% (n = 53) endorsing the need for informed consent, and 61.6% (n = 45) acknowledging the importance of renal function assessment prior to contrast administration. A strong demand for additional training was evident, with 89.0% (n = 65) of participants expressing the need for enhanced educational interventions, including workshops and simulation-based learning. Qualitative responses further emphasised this need, with preferences for regular

practical workshops (n = 40) and integration of contrast safety modules into academic curricula (n = 25).

## DISCUSSION

This cross-sectional survey provides a structured evaluation of knowledge levels, preparedness, and safety-related practices concerning contrast media use among radiology students, interns, and technicians. The findings demonstrate statistically relevant gaps in training exposure, emergency preparedness, and institutional protocol awareness, despite generally acceptable theoretical knowledge in certain domains. The predominance of radiology students (57.5%) among respondents is a critical contextual factor, as it reflects a cohort still in formative stages of professional development. While a high proportion correctly identified gadolinium-based contrast agents for MRI (86.3%) and commonly used iodinated agents such as Iohexol and Iopamidol for CT, a substantial minority were unable to consistently differentiate between contrast types. This partial knowledge gap mirrors earlier studies that reported limited pharmacological understanding of contrast agents among radiology trainees and allied healthcare personnel<sup>[10,11]</sup>. Awareness of contrast-induced nephropathy (CIN) was moderate, with 74% recognising pre-existing renal impairment as a major risk factor. However, this level of awareness remains suboptimal given the well-documented association between renal dysfunction and contrast-related nephrotoxicity<sup>[4,6]</sup>. Although key pre-procedural safety practices such as obtaining informed consent (72.6%) and assessing renal function (61.6%), were reported by a majority of participants, the observed variability indicates inconsistent adherence to recommended safety protocols, as similarly reported in previous studies<sup>[5,7]</sup>.

Recognition of contrast media reaction symptoms was comparatively stronger for commonly encountered clinical manifestations. Most respondents correctly identified mild reactions such as nausea and vomiting and severe reactions such as respiratory distress. However, this theoretical awareness was not matched by practical readiness. Only 32.9% had received structured training in contrast reaction management, and 35.6% reported hands-on emergency training. Furthermore, 76.7% had never witnessed a contrast reaction in a clinical setting. These findings are consistent with earlier regional surveys from India that documented limited emergency exposure and preparedness among radiology personnel<sup>[11,13]</sup>. Emergency management knowledge demonstrated mixed outcomes. While 72.6% correctly identified epinephrine as the first-line treatment for severe anaphylactic reactions, only 54.8% expressed confidence in assisting during an actual emergency. This

discrepancy between cognitive knowledge and self-perceived competence strongly suggests the influence of inadequate experiential learning. Similar observations in prior literature support the role of simulation-based and hands-on training in improving confidence and clinical performance during contrast-related emergencies [13,14]. Awareness of institutional standard operating procedures (SOPs) was also inconsistent. Although 58.9% acknowledged the existence of reaction classification systems and protocols, a substantial proportion reported lack of formal orientation or training regarding these guidelines. This disconnect between institutional policy and staff awareness has been repeatedly highlighted in earlier studies as a contributor to suboptimal safety practices within radiology departments [9,15]. Importantly, the study identified a strong consensus regarding the need for improved education and training. An overwhelming 89% of participants advocated for regular workshops, simulation-based learning, and curriculum-integrated contrast safety modules. These recommendations align closely with guidelines issued by professional bodies such as the American College of Radiology (ACR) and the European Society of Urogenital Radiology (ESUR), which emphasise structured education, periodic competency updates, and emergency preparedness training for all professionals involved in contrast administration [7,8,14,15].

## CONCLUSION

This study demonstrates that while radiology students, interns, and technicians possess moderate theoretical knowledge regarding contrast media, substantial gaps persist in practical preparedness, emergency response skills, and adherence to institutional safety protocols. Limited formal training, inadequate exposure to real-time contrast reactions, and inconsistent awareness of standard operating procedures collectively hinder effective and safe contrast administration. The strong demand for workshops and simulation-based teaching further underscores the need for structured, competency-focused educational interventions. Strengthening academic curricula, improving protocol dissemination, and implementing routine hands-on training programs are essential steps toward enhancing patient safety and ensuring that radiology personnel are adequately equipped to manage contrast-related emergencies.

## LIMITATIONS

This study has several limitations that should be acknowledged. The relatively small sample size and single-center design may restrict the generalizability of the findings to other institutions or regions. As the data were collected through self-reported responses, the results may be influenced by recall bias or social

desirability bias. Furthermore, the study did not include objective assessments such as simulation-based evaluations or observed clinical performance, which could have provided a more accurate measure of participants' actual competencies in managing contrast-related emergencies.

## RECOMMENDATIONS

In view of the observed gaps in knowledge and preparedness, it is recommended that radiology training programs incorporate structured, recurring workshops and hands-on simulation sessions focusing on contrast media safety and emergency management. Institutions should ensure that essential emergency equipment, including fully stocked crash carts, is readily available and that all personnel are oriented to its location and usage. Regular refresher courses, periodic competency assessments, and systematic dissemination of standard operating procedures (SOPs) should also be implemented to promote consistent and safe contrast administration practices across all levels of radiology personnel.

## ETHICAL STATEMENT

**Ethical Approval:** The study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, prior to initiation of the study. Written informed consent was obtained from all participants before inclusion. Patient confidentiality and anonymity were strictly maintained throughout the study, and all imaging procedures were performed following standard radiation safety guidelines.

**Conflict of Interest:** The authors declare that there are no conflicts of interest related to this study.

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**Data Availability Statement:** The data supporting the findings of this study are available from the corresponding author upon reasonable request and in accordance with institutional ethical guidelines.

**Author Contributions:** All authors contributed equally to the study conception, data acquisition, image analysis, interpretation of results, and manuscript preparation. All authors have read and approved the final manuscript.

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