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Original Article

Evaluation of the Level of Protection in Radiology Departments of Kermanshah, Iran

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Abstract

Introduction
Radiation protection is an important safety issue for radiographers and patients. The aim of this study was to assess the observance of radiation protection regulations in radiology departments of Kermanshah University of Medical Sciences, Kermanshah, Iran.

Materials and Methods
In total, 48 radiographers and 8 radiography rooms were evaluated in three hospitals of Kermanshah, Iran. Additionally, 120 patients were randomly selected in the present study. For data collection, a questionnaire on radiation protection devices, radiographers, and patients was completed. Data were analyzed, using Microsoft Excel.

Results
Based on the analysis, 56.8% of radiation protection devices were accessible to radiographers. Overall, 81.3% of radiographers stated that they utilized film badges for radiographic procedures, while only 71.7% had used these badges in practice. Additionally, 54.2% of radiographers claimed that they regularly performed medical check-ups; however, based on the documents available at personnel offices, only 43.8% had taken this measure into account. Also, 60.4% of radiographers claimed that they had participated in annual training courses, while based on the records, only 41.7% had participated in such courses.

Conclusion
The majority of radiographers had no regard for radiation protection principles for either themselves or the patients. Apparently, not only hospital authorities, but also heads of departments ignore radiation protection principles for the patients and radiographers.

Keywords: Patient safety, Radiation protection, Radiography, Diagnostic imaging.

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1. Introduction

Currently, radiography is a valuable routine diagnostic procedure. Low X-ray doses are normally used in conventional radiographic procedures [1]. Generally, based on previous research, management of major complications, particularly cancer and genetic disorders, could lead to patient exposure to low doses of radiation [2-5].

In order to reduce radiation effects, certain measures, including continuous radiation monitoring, periodic clinical examinations, annual training courses, and observance of radiobiological standards, must be simultaneously considered by radiology personnel [6]. Furthermore, to promote the level of radiation protection (RP), some devices and instruments should be utilized during radiographic processes [4, 7, 8]. These RP devices include lead aprons, lead glasses, lead gloves, gonad shields, thyroid shields, patient immobilization devices, and radiation area signs [9-11].

Previous studies have revealed low levels of observance regarding RP principles in certain radiology departments of Iran. This issue could potentially exacerbate the long-term effects of radiation either for the patients or the radiographers [12-19]. Considering the possible prevalence of this issue in most radiology departments around the country, we aimed to evaluate the level of adherence to RP principles in radiology departments of Kermanshah University of Medical Sciences, Kermanshah, situated in west of Iran.

2. Materials and Methods

This descriptive, cross-sectional study was conducted in 2013 in Kermanshah, which is one of the largest provinces in west of Iran. Three out of five hospitals (i.e., hospitals I, II, and III), affiliated to Kermanshah University of Medical Sciences, were selected. The hospitals were included in case they had conventional radiography departments. Therefore, hospitals with only MRI/CT scan devices or no conventional radiography devices were excluded from the study.

All eight radiography rooms of these three hospitals were included in our analysis: hospital I (4 rooms), hospital II (3 rooms), and hospital III (1 room). All 48 radiographers (including 27, 15, and 6 radiographers from hospitals I, II, and III, respectively), employed at the hospitals, participated in the present study. Furthermore, 120 patients, who referred to the hospitals for their radiographic examinations, were randomly selected. The number of patients admitted to hospitals I, II, and III was 50, 45, and 25 cases, respectively.

A checklist was completed with respect to the availability of the following devices in each radiography room: 1) lead glass windows, 2) lead aprons, 3) lead glasses, 4) lead gloves, 5) gonad shields, 6) thyroid shields, 7) patient immobilization devices, 8) radiation area signs, 9) illuminated signs indicating "no entry", 10) warning sign for pregnant women, and 11) safe lead doors.

Moreover, a questionnaire was prepared, based on the recommendations by the International Commission on Radiation Protection (ICRP) and Radiation Protection Department of Atomic Energy Organization of Iran (AEOI). The questionnaire focused on six major research questions. The first three questions addressed radiographers' protection and the other three assessed patients' and attendants' protection.

Overall, the mentioned questions focused on the following issues: 1) use of individual film badges by radiographers; 2) periodic medical check-ups; 3) participation in annual training courses; 4) utilization of lead shields for patients and/or their attendants, if required; 5) use of mechanical support for immobilizing patients during radiographic procedures, if necessary; and 6) adherence to the ten-day rule in radiobiology.

At the time of completing the questionnaires, the radiographers were not informed about their engagement in the study. However, three months before the onset of research, the radiographers

were officially informed about their future participation in this study. In fact, if the radiographers had not been blinded to the study, they might have reconsidered their theoretical answers or reactions to the main research questions.

The follow-up information was also obtained in a private interview with the radiographers. The radiographers' opinions about the follow-up process after dosimetry at radiology departments, medical check-ups and the associated financial issues, training course conditions, and the role of department heads and hospital managers were also reviewed.

Furthermore, an official permission was obtained from the Research Council of the University. All procedures in this study, which involved human participants, were in accordance with the ethical standards of the Institutional Research Committee, 1964 Declaration of Helsinki, and the later comparable ethical standards [20]. The questionnaires were completed in a private interview with radiographers, and the necessary points were explained to the participants.

Afterwards, radiographers' performance was recorded and explored during an intimate interview with the admitted patients and their attendants. Additionally, to identify radiographers' performance regarding the second and third research questions, we referred to their official files, available in personnel offices at the hospitals; it should be mentioned that an official permission was obtained from the authorities. The sixth question was asked randomly from women, aged 12-55 years, who referred to the hospitals for radiographic procedures. Data acquisition continued until 120 women were interviewed. Data analysis was performed, using Microsoft Excel

3. Results

The findings on three major aspects of the study are summarized in the following sections.

3.1. Accessible RP devices in radiography rooms

Table 1 presents a detailed analysis of RP devices available at radiography rooms. As indicated in Table 1, 62.5% of radiography rooms were equipped with a lead glass window. Additionally, in 87.5% of radiography rooms, a lead apron was accessible, and 75% of the rooms were equipped with gonad and thyroid shields.

Moreover, 66.5% of the rooms had a radiation area sign and an illuminated sign indicating "no entry". A warning sign for pregnant women was used in all rooms; in contrast, we found no lead glasses in any of the evaluated rooms. In 25% of the rooms, lead gloves and patient immobilization devices were accessible. In addition, 50% of the rooms had safe lead doors. In total, 56.8% of RP devices were accessible to radiographers in each radiography room in the hospitals.

3.2. Radiographers' protection

The detailed analysis of radiographers' statements and their performance regarding the major aspects of this study is presented in Figure 1. As indicated in this figure, 81.3% of radiographers stated that they used film badges, whereas in practice, only 71.7% of them had utilized these badges.

Moreover, 54.2% of radiographers claimed that they regularly performed periodic medical check-ups, while only 43.8% had conducted these check-ups, based on radiographers' official files. Additionally, 60.4% of radiographers stated that they had participated in annual training courses, whereas a participation rate of 41.7% was reported in the official records.

3.3. Patients' and their attendants' protection

Details of radiographers' statements and their performance on questions 4-6 are presented in Figure 1. Data shown in this figure are related to patients for whom RP lead shields were necessary. As this figure demonstrates, 54.2% of radiographers stated that they had utilized a protection device for the admitted patients, if necessary; however, in practice, the shields were used for only 19.2% of patients during radiographic procedures.

Additionally, 71.7% of radiographers stated that they had applied mechanical support to immobilize the patients, if necessary, while practically, only 51.7% of patients had been immobilized via mechanical support. In addition, 66.7% of radiographers claimed that they had adhered to the ten-day radiobiological law,

whereas only 41.7% had applied the rule in practice.

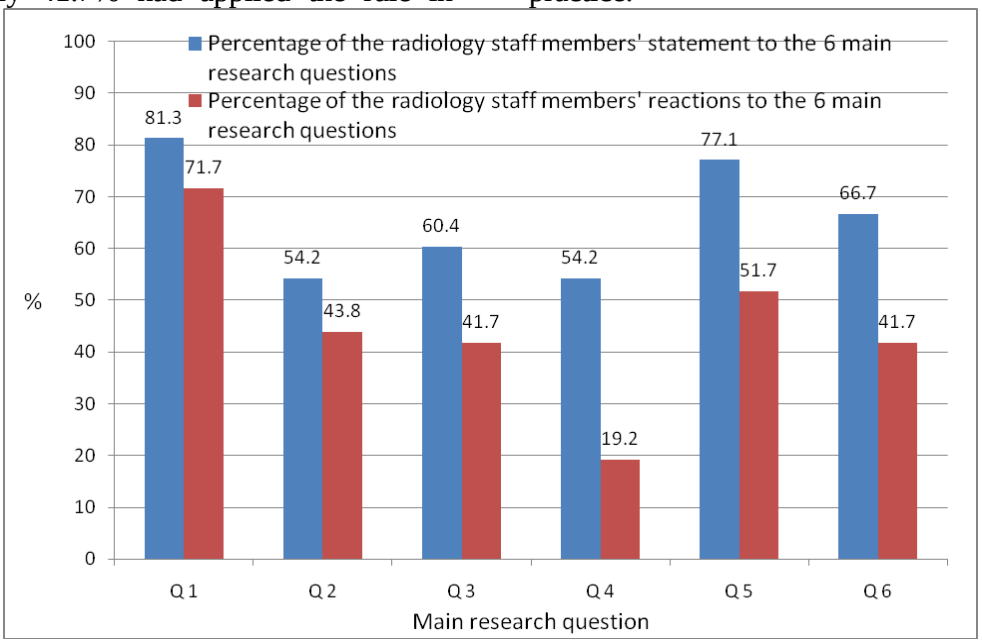

Figure 1. The radiographers' statements and performance regarding the six main research questions at the evaluated hospitals

4. Discussion

Since the present study evaluated three major aspects regarding RP level and the results were presented in three sections, the discussion will be also presented in the following three sections.

4.1. Accessible RP devices in radiography rooms

Our evaluation revealed that all radiography rooms had a warning sign for pregnant women (Table 1). Furthermore, the most accessible RP devices in each radiography room were lead aprons, gonad shields, and thyroid shields, respectively (Table 1). In fact, radiology departments are obliged to adhere to RP principles for the patients, especially pregnant women.

Contrarily, none of the radiography rooms (8 rooms) had accessible lead glasses. Moreover, lead gloves were accessible in only one-fourth of the rooms. Obviously, this is a disadvantage for radiology departments, since many of the patients refer for fluoroscopic examinations, and in these cases, an operator needs lead glasses and gloves to perform the procedures.

Additionally, in the present study, an immobilization device was accessible in only one-fourth of the rooms. This is in fact a defect for a radiology department, since immobilization devices are required not only to avoid excessive patient exposure due to radiography repetition, but also to reduce the dose received by the attendants. Moreover, since half of the radiography rooms had no safe lead doors, leakage and scattered radiation were highly expected. This could in fact increase the dose received by radiographers, patients, and their attendants. In the present study, the safety of lead doors was evaluated with respect to radiation leakage, based on the reports by the hospital physicists.

We also believe that lead glass windows are required in radiography rooms where the control panel is located outside. If this requirement is not met, use of these radiography rooms is prohibited, and the imaging process is deemed unacceptable. In a study by Tamjidi in Bushehr, situated in south of Iran, 88% of radiography rooms (22 out of 25) did not have a "no entry" sign. Also, 84%, 80%, 24%, and 20% of radiography rooms had no warning signs for pregnant women, gonad shields, safe lead doors, or lead aprons, respectively [16].

Moreover, in a study by Keikhai Farzaneh *et al.*, there was no lead glass in 50% of

radiology departments in Sistan and Baluchestan, Iran [21].

Table 1. Accessibility of ionizing radiation protection devices in radiography rooms of the evaluated hospitals

Devices		Hospital I (Room No.)				Hospital II (Room No.)			Hospital III (Room No.)	Sum and percentage of accessible devices in the three hospitals			
		1	2	3	4	1	2	3	1	nr.[@]	%[@]	nr.[†]	%[‡]
Lead glass window		Y*	Y	N	N	Y	Y	N	Y	5	62.5		
Lead apron		N*	Y	Y	Y	Y	Y	Y	Y	7	87.5		
Lead glasses		N	N	N	N	N	N	N	N	0	0		
Lead gloves		N	Y	N	N	N	N	N	Y	2	25	28	50
Gonad shield		N	Y	N	Y	Y	Y	Y	Y	6	75		
Thyroid shield		N	Y	N	Y	Y	Y	Y	Y	6	75		
Patient immobilization devices		N	Y	N	N	N	N	N	Y	2	25		
Radiation area signs		N	Y	Y	Y	Y	N	N	Y	5	62.5		
Illuminated "no entry" signs		N	N	N	Y	Y	Y	Y	Y	5	62.5		
Warning signs for pregnant women		Y	Y	Y	Y	Y	Y	Y	Y	8	100	22	68.8
Safe lead doors		N	N	N	N	Y	Y	Y	Y	4	50		
Accessible devices in each room	No.	2	8	3	6	8	7	6	10	50	56.8		
	%	18	72.7	27.3	54.5	72.7	63.6	54.5	90.9				
Accessible devices in each hospital	No.	19				21			10				
	%	43.2				63.6			90.9				
Accessible devices in the three hospitals	No.	50											
	%	56.8											

* Y: yes, N: no

[@] The numbers in the two columns indicate the sum and percentage of accessible devices (Y_s) in the three hospitals, respectively.

†The numbers in this column indicate the sum of numbers in the previous second column (column nr.@).

‡ The numbers in this column indicate the percentage of numbers in the previous column (column †).

This inconsideration may be due to the recklessness and negligence of department authorities, radiographers' disregard for RP principles, and hospital managers' insufficient knowledge. We believe that neither the authorities nor the radiographers pay enough attention to RP principles. Also, financial restraints do not seem to be the problem here,

since the shortage in these facilities could be eradicated via cost-effective measures.

4.2. Radiographers' protection

We evaluated radiographers' statements and actual performance regarding the first major issue in this study. In theory, almost 81.3% of radiographers believed that they should use film badges, while only 71.7% had applied these badges in practice (Figure 1). Eyvaz Zadeh *et al.* revealed that all radiographers in radiology centers of army hospitals in Tehran, the capital of Iran, used their own film badges [22]. Similarly, Amirzadeh *et al.* and Borhani separately showed that 85% and 88% of radiographers applied film badges in practice in Shiraz (south of Iran) and Kerman (east of Iran), respectively [18, 23].

Similarly, Tamjidi showed that 60% of radiographers in Bushehr used their own film badges [16]; these findings were in agreement with the present results. Based on ICRP recommendations, all radiation workers are obliged to use film badges [24]. However, in the present study, roughly 30% of radiographers did not utilize film badges, despite their accessibility. This question arises as why these radiographers refused to use the badges. In our interviews, nearly one-third of radiographers believed that patient follow-ups after dosimetry were ineffective in radiology departments; this is probably the reason behind radiographers' avoidance of film badges.

The second main question in this study addressed periodic medical check-ups. We found that less than half of the radiographers regularly performed medical examinations (Table 1). Borhani also found that 60% of radiographers performed regular medical examinations [23]. This may be due to lack of patient follow-up by hospital authorities or economic issues. In the interviews, 50% of radiographers stated that they could not pay for the clinical exams. They also believed that hospital managers should provide an opportunity for radiographers to facilitate their periodic medical check-ups at lower costs. Moreover, hospital authorities should encourage radiographers, who are more active in this regard.

The third major question in this study focused on radiographers' active participation in annual training courses. We found that less than half of the radiographers took part in these courses (Table 1). Similarly, in a study by Borhani, 50% of radiographers participated in annual training courses [23]. In our study, nearly half of the radiographers had complaints about the time and conditions of the courses. We believe that hospital managers could promote the active participation of radiographers in annual training courses.

The comparison of radiographers' statements and performance regarding the first two research questions showed less than a 10% difference. However, this comparison regarding the third research question indicated a nearly 20% discrepancy. This difference is of significance as the radiographers were required to honestly respond to the questions. Such differences could be due to radiographers' inadequate attention while completing the questionnaires. In fact, radiographers' unawareness of their engagement in this survey while completing the questionnaires might have resulted in their inaccurate responses to the questions.

4.3. Radiation protection of patients and their attendants

Based on our data analysis, almost half of the radiographers stated that they were required to use protective shields for the patients and/or their attendants, if needed; however, in practice, nearly one-fifth of these radiographers used these shields (Figure 1). Also, more than three-fourths of radiographers theoretically believed that they should utilize an immobilization device in order to hold the patient during radiography, if necessary; however, in practice, roughly half of them employed this device (Figure 1).

In our study, two-thirds of radiographers stated that they adhered to the ten-day radiobiological law, whereas less than half of them applied this rule in practice (Figure 1). In a study by Fawcett *et al.*, application of RP devices was reported in 70% of cases, among

whom only 38% carefully used these devices [25]. Also, Amirzadeh *et al.* reported that 43% of radiographers in Shiraz used a lead apron for patient protection [18]. In contrast, in a study by Goudarzi Pour *et al.*, none of the radiographers applied a thyroid shield for the patients, when necessary in Yazd, central Iran [12].

It seems unreasonable to expect radiographers to use RP devices, while access to such devices is quite limited. However, in the present study, radiographers cannot make such a claim, since half of the lead shields were accessible in the evaluated hospitals (Table 1). Also, it should be mentioned that hospital III has a highly equipped radiography room, with 90.9% of RP devices being accessible to the radiographers (Table 1); however, in this hospital, almost half of the radiographers did not use RP devices in practice (Figure 1). This failure could be due to radiographers' negligence regarding patients' and/or their attendants' protection, despite their awareness and knowledge on this issue.

Most of low-dose radiographic procedures are not completely safe for either the radiographers or the patients. In our opinion, some radiographers did not pay attention to this point. Based on our literature review, a zero radiation dose is considered to be safe for individuals [4]. Furthermore, radiobiologists believe that the effects of radiation at very low doses (e.g., radiographic procedures) to a large population are similar to the effects of radiation at very high doses (e.g., nuclear accidents) to a small group of people. In fact, they both equally contribute to an increase in long-term radiation effects [26-28].

According to RP principles, negligence of radiation workers regarding the proper use of protection devices is considered a crime with legal ramifications [29-33]. Therefore, radiographers must adhere to “as low as reasonably achievable” (ALARA) principle. By reminding radiographers of this principle, RP standards may be taken more seriously.

Based on the results of the present study and previous national research [12, 16-21], one can conclude that in many radiology departments of Iran, observance of RP principles is insufficient. Our suggestion is that heads of radiology departments and hospital managers provide an atmosphere in which radiographers can optimally use the available facilities, perform their periodic medical check-ups, and participate in annual training courses. Radiographers should be encouraged on this issue and be financially supported; moreover, adequate time should be allocated to training courses. Also, hospital managers should promote the RP level by regular monitoring of radiation safety at radiology departments and adequately follow-up the results. Of course, in some specific cases, adherence to RP principles should be mandatory [34-36].

5. Conclusion

Despite the availability of protective devices in radiology departments in the present study, the number of these devices was inadequate in the hospitals. Furthermore, although radiology staff members should try to reduce the patient dose based on ALARA principle, the majority disregarded RP standards for either the patients or themselves. It seems that heads of departments and hospital authorities are not concerned about the status of RP principles for either the staff members or the patients.

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