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Evaluation of Radiographers' Knowledge, Attitudes, and Performance Regarding Gonadal Shielding in Diagnostic Radiology Examinations: Southern Khorasan Province Hospitals of Iran

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Abstract

Background: Nowadays, ionizing radiation is increasingly used in medicine. One of the most frequent X-ray examinations is pelvic radiography. Gonads are susceptible in the pelvic area. Gonadal shielding (GS) is a useful method to reduce the received dose by gonads. Despite the benefits of using gonadal shielding, it is rarely used by radiographers.
Methods: This cross-sectional study was carried out in ten governmental hospitals with 300 radiographs.
Results: The radiographers' knowledge of using GS had a value equal to 59.1%. However, the radiographers did not have enough information on the subject, although their awareness about the significance of GS was acceptable.
Conclusions: Although the radiographers believed in the necessity of using GS for pelvic, abdominal, and spine examinations, they used no shields.

Keywords: Radiation Protection, Radiography, Gonadal Shielding, Gonads, Pelvic Radiography

1. Background

Medical imaging based on ionizing radiation has a vital role in disease diagnosis and treatment. More than 10 million diagnostic radiology procedures have been performed around the world (1). Although the benefits of diagnostic radiology have been proven, the harmful effects of ionizing radiation remain an inevitable problem (2-5). Conventional radiography, known as low dose radiation, is the most common imaging procedure among various imaging methods. According to the linear no-threshold theory, there are no safe doses of ionizing radiation, although the effects of low doses may not be seen precisely after exposure and may become apparent in the next generation of exposed individuals. Thus, based on the ALARA principle, patient dose optimization and radiation protection (RP) techniques should be considered (3).

Optimization is a balance between radiation doses and image quality so that the patient dose becomes as low as possible and the image quality remains intact (6, 7). There are different ways to reduce the patient dose in the RP field, such as patient positioning, patient immobilization, using appropriate collimation and filtration, using protective shields, using small focal spots, using grids, and reducing the exposure time (8).

Gonads are among the most important organs that should be shielded so that their received dose becomes as low as possible (9, 10). Based on the radiobiology principles, the rapid division of gonad cells is the crucial point. This property of gonad cells makes them more sensitive to radiation damages than other cells. Genetic effects are among the probabilities of reproductive cell irradiation because ionizing radiation can lead to mutations in germ cells and inherited future generations (11). Hence, it is essential to consider the RP principles and guidelines to reduce the radiation exposure of gonads to as low as reasonably achievable (12). Two types of most common shields are gonad shields and lead-lined aprons. Gonad shields are small size shields used to cover gonads in the imaging field, while lead-lined aprons are large size shields used to protect organs outside the imaging field.

Gonads suffer too many harmful effects after radiation exposure, and even small radiation doses may affect them. One of the most repeated X-ray examinations is pelvic ra-

diography. Gonads are susceptible to receiving high doses in radiography examination around the pelvic area.

According to ICRP, the probability of genetic damages is about 10 per 1 million persons per mSv. Since 1950, gonadal shielding (GS) has been concerned as a practical method to reduce the radiation exposure of Gonads. GS reduces received doses to the testes by about 95% and to the ovaries by about 50%. Therefore, GS may be highly effective and play an essential role in decreasing genetic effects (13, 14). There are rules and protocols for using GS: GS should be considered when the patient is at or below reproductive age; GS should be inserted when gonads are placed within the radiation field or near the field; and GS should not be an excuse to lead inappropriate patient positioning and poor beam collimation.

GS was first used in 1900 to protect men against sterility (15). In 1950, anxieties about the risk of radiation on sterilityincreased, and GS was again recommended as a protective tool (13). One crucial point is that GS should be applied so that clinical information remains intact (15-17).

Despite the GS advantages, it has been rarely used due to reasons, such as radiation technologists' lack of confidence or skill in proper shield positioning, their fear of repeating radiography, and their improper attitudes about the importance or necessity of shielding. Doolan examined females' pelvic radiography and indicated that gonad shields were mislocated in 100% of the cases (9). Muscat (18) showed that gonad shields for males were accurately located in 20.8% of the cases in all images. Also, the inaccurate positioning of gonad shields led to the repetition of 15.8% of pelvic examinations (19, 20).

2. Objectives

Therefore, regarding the significance of GS, this study aimed to assess radiographers' knowledge and attitude about the necessity of GS application in conventional radiography. The study also intended to evaluate radiographers' performance while using shielding facilities in radiography units.

3. Methods

This cross-sectional study was carried out in ten general governmental hospitals in Southern Khorasan Province, east of Iran, between December 2018 and March 2019. The study population was radiographers working in radiography departments. The inclusion criterion was signing informed consent. Accordingly, 122 out of 158 radiographers participated in the study.

The study protocol was approved by the Ethics Committee at BUMS according to the ethics code Ir.bums.REC.1396.28. All the participants participated in the study voluntarily and completed a hand-delivered questionnaire. The participants were assured of the confidentiality and privacy of their information. The radiographers' performance in using GS in pelvic regions was evaluated throughout direct observation and checking 300 radiographs from the picture archiving and communication system in ten hospitals. GS facilities in these hospitals were assessed using a checklist.

The researchers developed a questionnaire that was validated by some physicists. After revisions, some radiographers were selected to answer the questionnaire and determine its reliability using the test-retest method. The two-week interval reliability of the questionnaire was confirmed with a correlation coefficient of 0.74. The questionnaire was prepared to evaluate the radiographers' knowledge about the RP principles and their attitude toward GS in conventional radiography. Questions for assessing knowledge included seven multiple-choice questions, and the questions of attitude, which were in two parts, were scored based on a five-item Likert scale from 20 (very low) to 100 (very high).

4. Results

Among the 158 radiographers receiving the questionnaire, 122 completed and returned it to the researcher, making the percentage of participation equal to 77.21%. The participants consisted of 61 males (50%) and 61 females (50%). In terms of qualifications, 79 of the participants had a bachelor's degree, and 43 had an associate degree.

We found out that GS was only used for four out of 50 femur examinations, and the rest were performed without applying GS. The radiographers' attitudes about the effectiveness and necessity of using GS showed values equal to 83.4 and 86.4, respectively. The maximum score based on the Likert scale, was 100. The results of evaluating the radiographers' knowledge about using GS are shown in Table 1.

Table 1. The Radiographers' Knowledge About the Use of GS

Questions	No. of Correct Answers (%)
The awareness of ionizing radiation risks	86 (70.5)
The awareness of ionizing radiation	101 (82.8)
The awareness of the sensitivity of gonads	68 (55.7)
The awareness of radiation dose to gonads	82 (67.2)
The maximum permissible gonad dose	46 (37.7)
The awareness of the effect on GS	68 (55.7)
The awareness of the GS laws	54 (44.3)

The radiographers' attitudes toward factors influencing the use of GS are shown in Table 2.

Table 3 shows the radiographers' attitudes regarding the necessity of using GS.

Table 4 compares the radiographers' knowledge and attitude based on gender, education level, and work experience.

Table 5 shows the relationship between the work experience and the amount of co-workers influence among the radiographers.

5. Discussion

The radiographers' level of knowledge about ionizing radiation and hazardous risks was found to be defensible. However, they did not have enough information about the necessity of using GS.

Against their positive attitudes on the importance of GSgonad shielding, they had poor awareness of this.

Concerning influential factors on the radiographers' attitudes that directly affected their performance, various factors, including demographic, patient, and environmental factors, were studied. The participants' age had the most significant effect on their attitude, which is justifiable by considering Table 1 and their reasonable level of awareness about high sensitive groups to ionizing radiation. This evidences the direct effect of knowledge on attitude. The radiographers' familiarity with the number of facilities in each unit was another critical reason influencing awareness that agrees with Teferi et al.'s results (21). The findings of MacKay et al. indicated that GS facilities in departments rarely affected the radiographer's intention to use them (2). Based on our observation in the studied hospitals, the lack of GS facilities in the radiology departments led to the radiographers' undesirable performance. Hence, concise supervision should be carried out and even enforced as mandatory to use GS.

Another essential point based on the radiographers' perspective is that mandatory rules as an environmental factor in radiology departments can be even more effective than authorities' supervision. However, there was no protocol or rules regarding GS in any of the diagnostic radiology rooms in these hospitals. The results of Karami et al. and Doolan et al. are similar to our findings, showing no protocols or rules regarding GS (7, 9, 22, 23). On the contrary, the patients' level of education and appearance had the least effect on the radiation workers' attitudes. The reason can be the patients' unfamiliarity with their rights, even patients with a high education background. The workload and fatigue of the radiographers may be the main reasons for not using shields. This condition can be managed by better planning and ensuring that there is a balance between the workload and the number of radiographers on shifts. Karami et al. reported that the use of GS led to obscuration of important anatomical landmark.

Repeat of examinations were required in 21.5% and 10.6% of girls' and boys' radiographs, respectively (23). According to Karami et al.'s (23) study, misplacing gonad shields conducted to exposure repetition has caused to fear some radiographers. The fear of repeating radiographs was another important factor, proving that, in relation to other factors, had a relatively small effect on their performance; This situation was predictable due to inadequate monitoring of the radiographers' performance and lack of attention to staff errors and evaluation forms. Based on the radiographers' attitude about the importance of using GS depending on patients' gender, the most tangible point was that they believed in using it for female patients than for male patients.

As shown in Table 3, there is a significant relationship between knowledge and performance, which this relationship is strong evidence for the necessity of in-service education of radiographers. We found that the most crucial factor concerning work experience was the relationship between more work experience and radiographers. However, they had high felt from colleagues. This was probably because the other staff were confident in their knowledge, performance, and experience.

Teferi et al. reported that although radiographers' attitudes and knowledge were good, none applied gonad shield during their practice (24).

Also, despite the radiographers' attitudes about the importance of GS for pelvic, abdominal, and spinal cord x-ray examinations, no shields were used for these radiographs (0.0%), which can be attributed to various factors. These results are in agreement with the result of MacKay et al. (2). Also, these findings are the same as the findings of Karami et al.'s study. They found that the GS prevalence was less than 0.2% (7). The use of GS for the mentioned radiographs, due to the possibility of interference with critical anatomical details, requires high skills and self-confidence. These are reasons why radiographers rarely implement GS (20). On the other hand, based on the obtained results, the radiographers' knowledge about the sensitivity of gonads and the effect of using shields were not sufficient, and there was no mandatory monitoring or law in this regard, so that the radiographers preferred to take radiographs without applying shields.

5.1. Conclusions

The participants' responses demonstrated that they had positive attitudes toward using GS, although their GS performance was very poor and they rarely used GS. We

Table 2. The Mean and Standard Deviation of the Radiographers' Attitudes Toward Factors Affecting the Use of Gonadal Shielding

Questions	Mean	Questions	Mean
Individual Factor			
Level of education	73.0 (17.0)	**The difficulty of shielding**	62.4 (24.6)
Skill level	72.6 (21.2)	**Fear of repetition**	57.0 (26.4)
Impact rate from colleagues	69.2 (27.8)	**Fatigue of radiographers**	72.2 (23.8)
Patient Factor			
Patient gender	81.2 (21.0)	**Patient restrictions**	68.4 (17.8)
Patient's age	89.8 (15.6)	**patient's education level**	50.4 (23.0)
Type of graph	80.6 (16.4)	**The presence of patient companionship**	50.6 (26.6)
Environmental Factor			
The existence of mandatory rules	78.4 (20.2)	**Staff performance**	64.2 (22.2)
Correct training	70.6 (18.8)	**Monitoring by Supervisor**	70.0 (20.6)
Workload	72.6 (20.2)	**The number of facilities**	81.4 (17.0)

Table 3. The Mean and Standard Deviation of Radiographers' Attitude Toward the Necessity of Using Gonadal Shielding

Variables	Mean (SD)
Patient's age (y)	
0 - 19	85.8 (21.6)
20 - 39	81.2 (15.4)
40 - 59	61.8 (16.0)
60 - 79	40.0 (16.4)
+80	31.4 (17.6)
Types of examination	
Pelvic	85.2 (17.4)
Abdominal	76.0 (18.0)
Spinal Cord	68.2 (20.2)
Other organs	51.6 (20.6)
Lung	46.2 (23.6)
Patient gender	
Male	71.4 (28.2)
Female	76.8 (24.8)

Table 4. The Relationship Between Knowledge and Attitude

Variable	Attitude (%)	Knowledge (%)
Women	84.4	59.0
Men	85.8	59.3
P-value	> 0.05	> 0.05
Associate's degree	78.6	47.2
Bachelor	88.6	65.6
P-value	< 0.05	< 0.05

strongly recommend providing GS protocols in each x-ray room to improve the radiation staff's awareness about this problem. Another point to mention is that healthcare authorities should strongly inspect and control radiographers' use of GS and emphasize the significance of GS in the undergraduate medical imaging curriculum. Also, a comprehensive, regularly retraining course should be scheduled in hospitals to enhance the staff's knowledge and awareness of the necessity of using GS for patients. Despite radiographers' point of view about the necessity of using shields in pelvic, abdominal, and spine graphs, no shields were used (0.0%).

Footnotes

Authors' Contribution: Study concept and design: H. Z and S. A; Analysis and interpretation of data: H. Z., N. H, A. G, and S. A; Drafting of the manuscript: A. G and S. A; Critical revision of the manuscript for important intellectual content: N. H, H. Z, and S. A; Statistical analysis: N. H and A. G

Conflict of Interests: The authors declare that there are no conflicts of interest.

Ethical Approval: The study protocol was approved by the Ethics Committee at BUMS according to ethics code Ir.bums.REC.1396.28.

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Table 5. The Relationship Between Work Experience and the Radiographers' Attitude Toward Factors Affecting the Use of Gonadal Shielding

Questions	Work Experience				
	18 - 30	11 - 17	6 - 10	3 - 5	0 - 2
Influence of colleagues	%43.4 (1.4)	%63.4 (1.1)	%66.4 (1.5)	%71.4 (1.5)	%82.6 (1.0)

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