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ORIGINAL RESEARCH

The Actual Role of Iterative Reconstruction Algorithm Methods in Several Saudi Hospitals As A Tool For Radiation Dose Minimization of Ct Scan Examinations

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Background: Iterative reconstruction algorithm (IR) techniques were developed to maintain a lower radiation dose for patients as much as possible while achieving the required image quality and medical benefits. The main purpose of the current research was to assess the level and usage extent of IR techniques in computed tomographic (CT) scan exams. Also, the obligation of practitioners in several hospitals in Saudi Arabia to implement IR in CT exams was assessed.

Material and Methodology: The recent research was based on two studies: data collection and a survey study. Data on the CT scan examinations were retrospectively collected from CT scanners. The survey was conducted using a questionnaire to evaluate radiographers' and radiologists' perceptions about IR and their practices with IR techniques. The statistical analysis results were performed to measure the usage strength level of IR methods.

Results and Discussions: The IR strength level of 50% was selected for nearly 80% of different CT examinations and patients of different ages and weights. About 46% of the participants had not learned about IR methods during their college studies, and 54% had not received formal training in applying IR techniques. Only 32% of the participants had adequate experience with IR. Half of the participants were not involved in the updating process of the CT protocol.

Conclusion: The results indicate that the majority of radiographer and radiologist at four different hospitals in Saudi Arabia have no explicit or understandable knowledge of selecting IR strength levels during the CT examination of patients. There is a need for more training in IR applications for both radiologists and radiographers. Training sessions were suggested to support radiographers and radiologists to efficiently utilize IR techniques to optimize image quality. Further studies are required to adjust CT exam protocols effectively to utilize the IR technique.

Keywords: computed tomography, CT, filter back projection, FBP, iterative reconstruction algorithms, IR, as low as reasonably achievable, ALARA

Introduction

Computed tomographic (CT) is an essential imaging technique in which x-rays combined with computers are used to diagnose defects in various parts of the human body. It has made remarkable advancements during the last few decades in diagnosing defects in human body organs, tissues, and bones. The diagnostic advantages offered by CT scans have significantly increased the number of CT scan studies and expanded their applications.[1] Physicians have positioned CT at the top of the list of medical imaging modalities, as it has enhanced patient care. While the advantages of CT have been well documented, the high

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radiation dose delivered to the patient is still the main concern in CT scan studies.[2] The applications of CT scan modalities have been expanding and extending; consequently, radiation exposure to patients has increased.[3]

Due to the high radiation exposure capability of present-day helical and multi-slice helical CT, radiologists ought to know about the radiation risks of CT and work effectively to minimize radiation exposures as low as possible while maintaining the diagnostic image quality and medical benefits. Few studies have been carried out on radiation from CT scan studies in the United States, which similarly disclosed that about 1.5–2% of cancer in patients is due to these radiation exposures.[3]

CT is a crucial and highly used imaging technique in pediatric patients due to its significance and precision in diagnosis.[4] Radiation exposure is the major disadvantage of CT; specifically, it becomes more dangerous for children, who are extremely more sensitive to radiation than adults. It is estimated that the sensitivity of pediatric organs to radiation doses can be about ten times that of adults.[5,6] Adolescence, as well as during a critical period of growth and organ development, can be very sensitive to this radiation, which may cause permanent damage to body tissues and organs.[7] Due to this dangerous effect of radiation on the human body, particularly on sensitive organs such as gonads, the thyroid gland, and the lens of the eye, the radiation dose amount must be maintained as low as possible without compromising the image quality and diagnostic process of ALARA (as low as reasonably achievable).[8–11]

ALARA is the main principle to be followed to reduce the radiation dose of CT scans for pediatrics.[12,13] Various methods and strategies based on individual patient attributes and CT technology have been explored for dose optimization. One strategy is by introduction and implementation of iterative reconstruction algorithm (IR) technique.[14] Filtered back-projection (FBP) is a widely used algorithmic technique for CT image reconstruction. It has the drawback of poor image quality at low radiation doses. IR provides better results, even at low radiation doses. If the radiation dose increases to obtain a high-quality image of an internal organ or another body part, it dramatically affects these body parts and leads to severe disease.

IR approaches are not new; indeed, they were the initially proposed method for data reconstruction in the early time of CT technology during the 1970s. It was not commonly used because of IR's limitations, besides the demand for faster and cheaper computers for massive data storage.

Recently, IR technique usage has been increasing day by day in clinical practices due to the high demand for precise and authentic results.[1] The high demand for this technique is due to its adequate and better results in the diagnosis of diseases with the lowest radiation dose.[15] IR techniques comprise three significant steps repeated iteratively. In the first step, the primary image is formed using the raw data produced by the CT scanner by utilizing the FBP algorithm. In the second step, artificial raw data is created by the forwarding projection of this primary image. Then, an updated image is created by correlating the simulated data with the measured raw data. This updated data is back-projected by FBP to get a new updated image, and this back-projection is repeated until the desired results are obtained. In the third step, a high-quality final back-projection image is produced. Several studies have shown that the IR technique improves image quality with a lower radiation dose than FBP.[16–19]

IR has several advantages compared to the traditional FBP technique, which has been used for the last four decades. Its excellent image quality and optimize noise at low radiation doses while conducting patient CT examinations have made it more common than traditional ones.[20,21] Even though the IR methods are widely available, the question is do the radiographers and radiologists benefit from its advantages and do they efficiently utilize it. Therefore, the study aims to assess the perceptions of radiographers and radiologists regarding the value of the IR technique and to measure the usage strength level of this technique in CT exams in Saudi Arabian hospitals. The study also aims to determine the protocols/studies that employ the IR technique based on the collected data.

Methodology

Collection of Data

Official approvals were obtained from the Human Research Ethics Committee of King Fahad Specialist Hospital (KFSH) ministry of health (MOH). Data on CT scan examinations were retrospectively collected from CT scanners or from the Picture Archival and Communication Systems (PACS) system. The Digital Imaging and Communications in Medicine (DICOM) data details, tags and headers of the acquired data are shown in Table 1.

Table 1 The DICOM Tags of Image Details

DICOM Image Details	Tag Headers
Gender	(0010,0040)
Age	(0010,0010)
CT exam	(0008,1030)
Patient's Weight	(0010,1030)
Manufacturer	(0008,0070)
Scanner model	(0008,1090)
kVp	(0018,0060)
mAs	(0018,1153)
Exposure time	(0018,1150)
Pitch	(0018,9311)
Exposure indices	(0018,1152)
AEC	(0018,9323)
DLP	(0018,9943)
CTDI	(0018,9346)
CTDIvol	(0018,9345)
FBP	(0018,1160)
IR strength	(0018,9769)

Abbreviations: AEC, Automatic exposure control; DLP, Dose–length product; CTDI, Computed tomography dose index; CTDIvol, CT dose index-volume; FBP, Filtered back projection; IR, Iterative reconstruction algorithm.

A questionnaire survey was also conducted using a questionnaire to evaluate radiographers' and radiologists' perceptions about IR, and their practices with IR techniques for the previous two months. A form was used to collect the required details. The questionnaire included four sections, followed by four open questions that allowed the participants to freely reflect on their own experiences and opinions regarding IR.

Section 1: Type of CT Scanner, Model, and Participant Information

The acquired data includes details of CT scan examinations, such as scanner type, model, respondents' gender and age, exam type, protocol parameters, radiation dose, and the reconstruction methods used. The profession of CT practitioners, their ages, their qualifications, and their experience are also noted in the survey questionnaire. The survey also provides information about the type of CT scanner manufactured and several scanner slices they used during the scanning process.

Section 2: Strategies for Image Quality Optimization and Dose Reduction

The second section was about image quality optimization and dose reduction strategies, where the participants were asked to indicate their agreement level regarding assigned statements. The agreement levels included strongly disagree, disagree, neutral, agree, and strongly agree. During the scanning process, thicker, and thinner slices were selected to avoid the effect of higher radiation whenever possible without losing the required image quality. According to patient size, increasing or decreasing kVp values were recorded for diagnostic purposes during the scanning process. Escalating and declining kVp values according to increased constant media density were also reported in this questionnaire. Automatic exposure control (AEC) strategies, such as care doses in siemens, are recommended in heart CT scans, which are also part of this survey section.

Section 3: Theoretical Knowledge of Participants About IR Technique

The third section of this research survey includes information about the theoretical knowledge of radiographers and radiologists about IR. This also includes training time and type, their experience in this field, and their knowledge about the IR strategy and dose. Also included are questions about respondent's knowledge of IR and its future advantages. The participants were asked to indicate their agreement level with particular statements. These levels include strongly disagree, disagree, neutral, agree, and strongly agree.

Section 4: The Application of IR According to Patient's Condition

This section of the research survey includes questions about applying IR according to patients' condition and their disease type, such as applying IR techniques to pediatric, neurology, emergency, and trauma patients. The effects of CT scan protocols on pregnant women and angiography examination are also included in this section. This section also includes the application of frequency of IR usage on different patients according to their age, gender, and size. These levels include never, rarely, sometimes, most of the time, and always.

Statistical Analysis

After gathering all of this information from four different hospitals during the last two months. The application of SPSS 16.0 (IBM Corp., New York, NY; formerly SPSS Inc., Chicago, IL) was used to analyze all the data sets. The results from different variable groups were tested and compared using the two-way ANOVA tool. Student's *t*-test was used to explore any significant differences between variable groups, radiographers, and radiologists, for example, between different hospitals, and respondents' qualifications. The differences in results were considered statistically significant based on the P-value of < 0.05.

Results

Section 1: Results Collected from CT Scanners & PACS Systems

In this study, CT scan examination data was collected for 127 patients, 81 males and 46 females. The patients aged from 5 months to 18 years, and their weight ranged from 5 to 80 kg. The patients were divided to eight age groups and eight weight groups. the collected patients data include 25 different CT scan examinations.

The results presented in Figure 1 are obtained from DICOM data of the CT images of different patients from CT scanners of one hospital in Saudi Arabia during the last two months. The data were divided into eight groups of patients

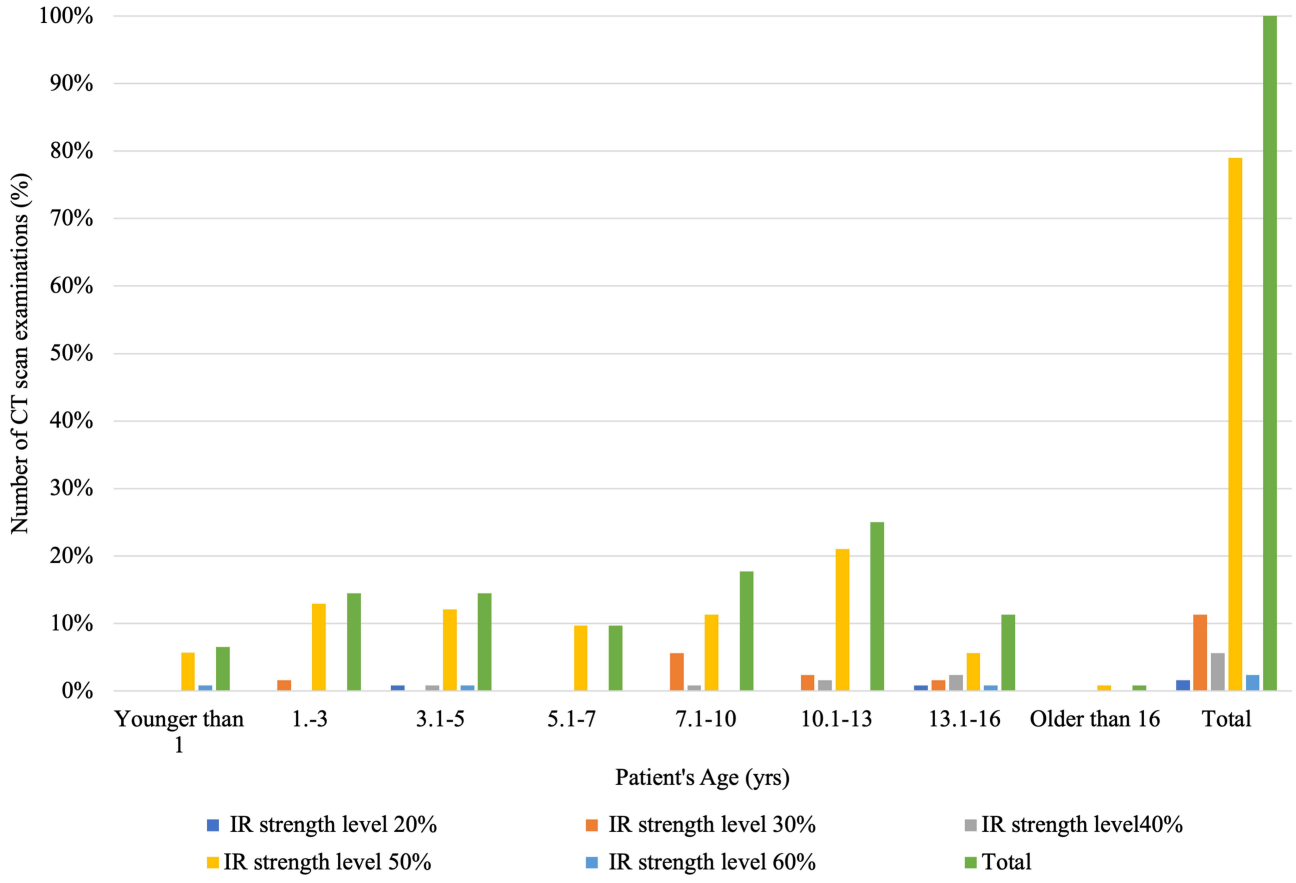

Figure 1 Graphical representation of IR strength level according to the patients' age.

of different ages. An IR strength level of 20–60% was selected for CT examination of patients aged less than one year to older than 16. The IR strength level of 50% was selected for most patients (98, 79%) of different ages, while 20%, 30%, 40%, and 60% were selected for 2, 14, 7, and 3 patients belonging to different age groups, respectively.

The patients were divided into eight groups according to their weight. The results represented in Figure 2 show information about the IR strength level selection for the patients belonging to different weight groups. An IR strength level of 20–60% was selected for the CT examination of the patients with weights from less than 5 kg to 70 kg. IR strength levels of 20%, 30%, 40%, 50%, and 60% were selected for 1, 13, 4, 90, and 3 patients, respectively. These results show that most CT scans were performed with a strength level of 50% for different patients' weight.

The data in Figure 3 were collected by radiologists and radiographers to investigate IR strength level usage during CT examination of different human body organs. This is also represented in Figure 3. Radiologists and radiographers selected an IR strength level of 20–60% for CT exams of different body organs.

An IR strength level of 20% was selected for CT of the thoracic lumbar (T/L) spine of two patients, and 30% were selected for CT exam of the abdomen, abdomen angio, chest, abdomen, pelvis, Kidney ureters bladder (KUB), neck, and shoulder. A total of 14 patients' organ scans were performed with an IR strength level of 30%. Cardiac, Lumbar (L) spine, pelvis, paranasal sinus (PNS), Thoracic (T) spine, and T/L spine scans of seven different patients were performed with a 40% radiation dose. Scans of 98 and 3 patients were done with 50% and 60% IR strength level, respectively. Surprisingly, one KUB (33.3%) scan was performed with a 60% strength level and a 100% abdomen angio with 30%. With the help of these data, we concluded that maximum scans were carried out with a 50% strength level.

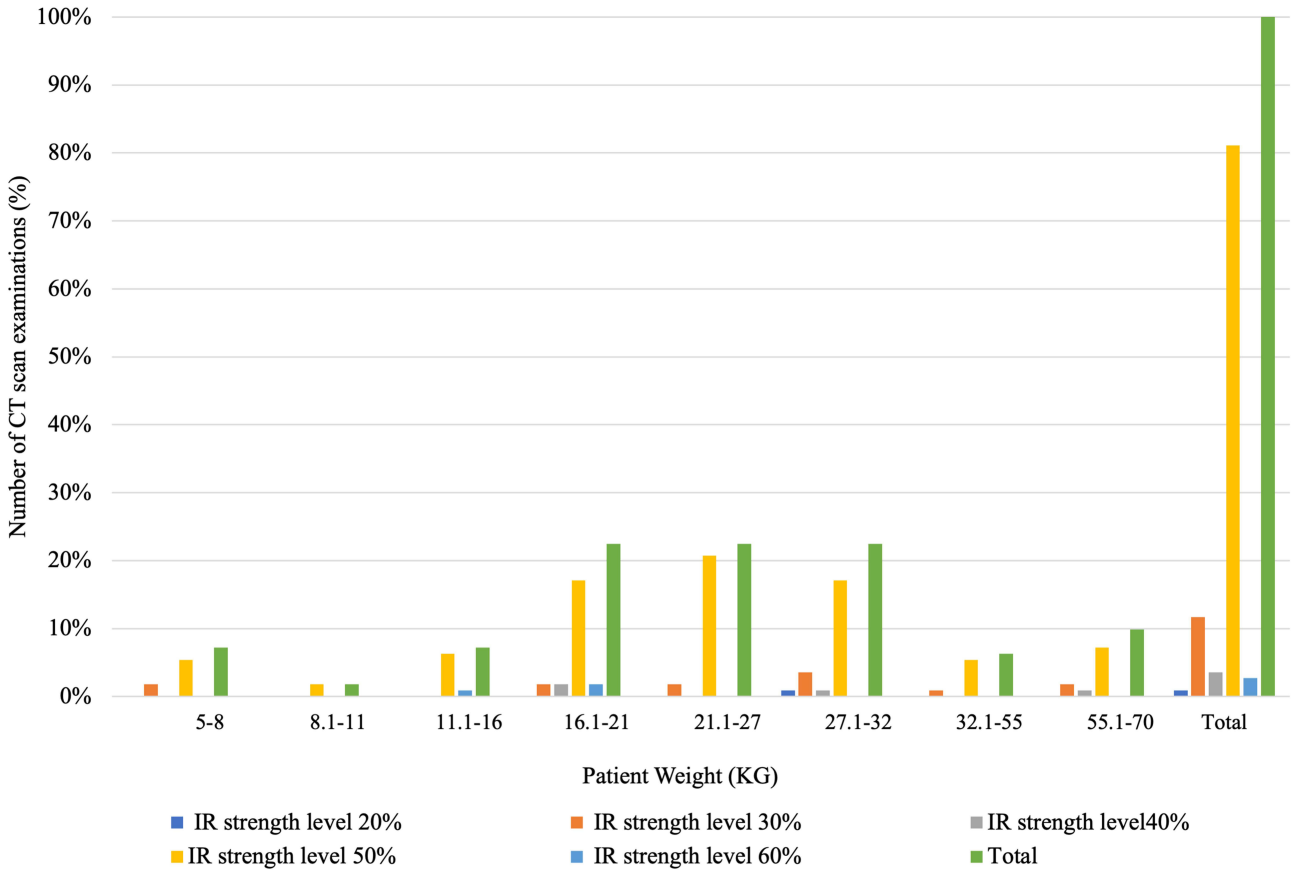

Figure 2 Graphical representation of IR strength level according to the patients' weight.

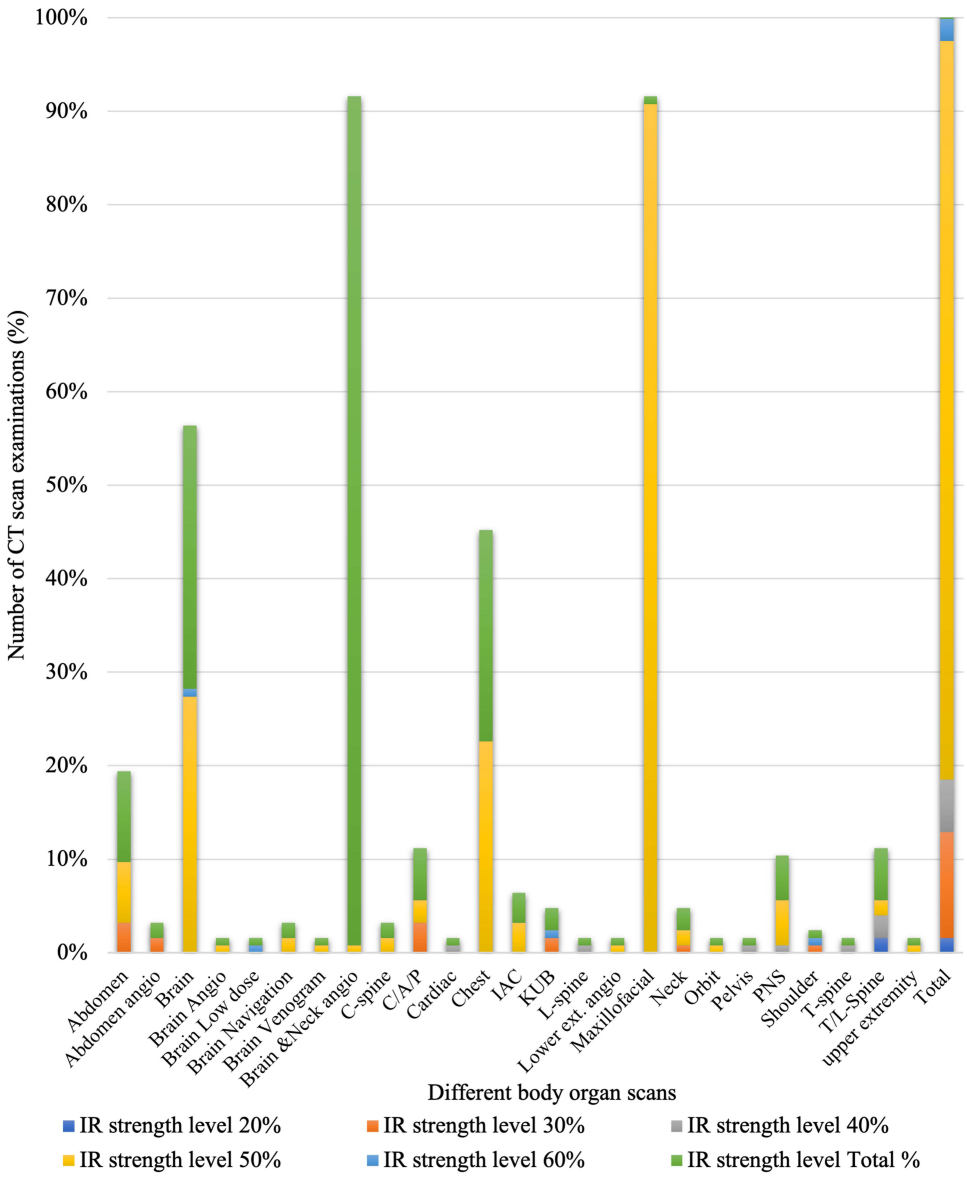

Figure 3 Graphical representation of IR strength level for scans of different body organs.

Section 3.2: Results Obtained from the Survey Study

The study included 41 participants, 11 radiologists and 30 radiographers (26.8% and 73% respectively). The majority of them were male (78%). The participants were from four different hospitals in Saudi Arabia. The demographic details of the participants are provided in Table 2.

Table 3 shows the participants' perceptions regarding the strategies of image quality optimization and dose reduction. The participants were asked to state their agreement levels with the assigned principles. The mean values of the response ranges were calculated for each question for radiographers and radiologists separately to investigate their differences. A mean value of 1 means strongly disagree, 3 means neutral, and 5 means strongly agree. *P*-values are provided in Table 3 to demonstrate any significant differences between radiographers and radiologists.

Most of the participants agreed that for diagnostic purposes, the rotation time, mAs, and kVp values would be adjusted according to patient size (56%, 63.5%, and 78%, respectively). Surprisingly, more than half of the respondents (53.5%) agreed to decrease kVp according to patient size for diagnostic purposes. Even though many respondents (58%)

Table 2 Demographic Details of Participants

Characters		Frequency (Percent)/n (%)
Profession	Radiologist	11 (26.8%)
	Radiographer	30 (73%)
	Total	41 (100%)
Gender	Female	9 (22%)
	Male	32 (78%)
	Total	41 (100%)
Age	25–27	7 (17%)
	28–34	6 (14.6%)
	35–39	9 (22.0%)
	40–43	6 (14.6%)
	45–49	6 (14.6%)
	Total	34 (82.9%)
Institution	H1	11 (26.8%)
	H2	8 (19.5%)
	H3	10 (24.4%)
	H4	12 (29.3%)
	Total	41 (100%)
Highest Academic Qualification	High diploma degree	2 (4.9%)
	Diploma	1 (2.4%)
	Bachelors	27 (65.9%)
	Masters	3 (7.3%)
	PhD	8 (19.5%)
	Total	41 (100%)
Years since obtained the qualifications	Up to 2 years	2 (4.9%)
	2.1–5	6 (14.6%)
	5.1–10	13 (31.7%)
	10.1–20	20 (48.8%)
	Total	41 (100%)

Table 3 Respondents' Means of Radiologists and Radiographers Regarding the Strategies of Image Quality Optimization and Dose Reduction

Your Profession	Radiologist			Radiographer			Total			Sig
	M	N	SD	M	N	SD	M	N	SD	Sig.
Adjusting mAs according to the patient size and diagnostic purposes:	3.82	11	1.537	4.27	30	1.048	4.15	41	1.195	0.293
Adjusting rotation time according to the patient size and diagnostic purposes	3.55	11	1.44	3.57	30	1.194	3.56	41	1.246	0.962
Thicker slice thicknesses are selected whenever possible without losing the required quality as the thinner slice leads to higher radiation	3.36	11	1.629	3.63	30	1.45	3.56	41	1.484	0.612
Thinner slice thickness is selected whenever possible without losing the required quality as the thicker slice leads to higher radiation	3.27	11	1.348	3.39	28	1.397	3.36	39	1.367	0.809
Increasing kVp according to the patient size and diagnostic purposes	3.64	11	1.567	4.03	30	0.928	3.93	41	1.127	0.324
Decreasing kVp according to the patient size and diagnostic purposes	3	11	1.483	3.83	30	1.262	3.61	41	1.358	0.082
Increasing kVp according to the increased contrast media density	5	1		2.52	23	1.31	2.63	24	1.377	0.077
Reducing kVp according to the increased contrast media density	1	1		2.87	23	1.217	2.79	24	1.25	0.147
Automatic exposure control (AEC) strategies are recommended to be used	5	1		4.22	23	0.85	4.25	24	0.847	0.377
Automatic exposure control (AEC) strategies are recommended to be used in head CT scans	1	1		3.61	23	0.891	3.5	24	1.022	0.009
Applying IR methods whenever appropriate	5	1		3.74	23	1.01	3.79	24	1.021	0.235

Abbreviations: M, Mean; N, Number of respondents; SD, Standard deviation; Sig, Statistical significance.

agreed to use thicker slices for diagnostic purposes, as thinner slices lead to higher radiation, slightly less than half of the participants agreed with the opposite results. Forty-four percent of them agreed that "the thicker slices lead to higher radiation." For the two statements regarding increasing or decreasing kVp values according to contrast media density, only 24 participants responded. They seemed likelier to be neutral or disagree (mean 2.63, n=24). Most of the responded participants generally agreed (62.5% out of 24 participants who responded) with applying IR methods whenever appropriate. Generally, the radiologists and radiographers had similar agreement levels with each statement of strategies of image quality optimization, and there were insignificant differences between them ($p > 0.05$). One exception to this was that there were significant differences ($p < 0.009$) between them as the radiographers strongly disagreed with "automatic exposure control (AEC) strategies are recommended to be used in head CT scans." The radiologist most likely agreed with this statement (mean 3.61, n=23).

To evaluate participants' theoretical knowledge about IR, they were asked to determine their agreement levels with several statements. Table 4 shows the conceptual statements and responses of the participants regarding their theoretical knowledge of IR. The results generally showed that respondents were likeliest neutral with the statements that expressed their theoretical knowledge about IR.

The respondents had varied points of view regarding their theoretical knowledge about IR (SD > 1). Less than half of the participants had not obtained knowledge about IR methods during their college studies, and more than half of them had not received formal training in applying IR applications (46% and 54%, respectively). Also, 24% and 34% of the participants were unsure about their knowledge and formal training, respectively, about IR. A minority of the participants (32%) had appropriate experiences with IR. Most of the participants (58.5%) agreed that IR advantages became limited by a lack of knowledge about its usage. A considerable percentage of participants (about 32%) agreed that the role of IR is still new and needs to be improved. The participant was almost neutral, with a respondent mean of 3.42 to the statement: "I see the future for IR methods".

Table 4 also shows the differences between radiologists' and radiographers' theoretical knowledge regarding IR CT exams based on the mean values of their responses. While the radiologists were neutral that they had obtained knowledge about IR methods during their study in university/college, radiographers were likelier not (mean = 3.18 and 2.5, respectively). Both radiologists and radiographers most likely did not receive formal training in applying IR (mean = 2.64 and 2.3, respectively). The result shows that there are insignificant differences between radiologists and radiographers regarding their knowledge about IR ($p > 0.1$).

This part of the survey was conducted to obtain information from radiographers and radiologists about the application of IR for common CT cases. The participants had different points of view (Table 5). While almost half of the participants agreed

Table 4 The Means of Agreement Levels of Participants (Radiologists and Radiographers) Regarding Their Theoretical Knowledge About IR According to the Mean Values of Their Responses

Participants Profession	Radiologist			Radiographer			Total			Sig
	Mean	N	SD	Mean	N	SD	Mean	N	SD	Sig.
I have obtained knowledge about IR methods during my college study	3.18	11	1.401	2.5	30	1.253	2.68	41	1.312	0.143
IR is an effective strategy to reduce radiation dose	3.91	11	1.3	4.07	30	1.048	4.02	41	1.107	0.692
IR methods can improve image quality	3.45	11	1.368	3.8	30	1.095	3.71	41	1.167	0.408
IR can reduce the effects of some kinds of artifacts, eg, dental fillings:	3.45	11	1.293	3.53	30	1.074	3.51	41	1.121	0.845
I have received formal training in applying for IR	2.64	11	1.362	2.3	30	0.988	2.39	41	1.093	0.389
I have appropriate experiences with IR	3.09	11	1.375	2.83	30	1.289	2.9	41	1.3	0.581
The advantages of IR are limited by time-consuming	3	11	1.265	2.9	30	1.029	2.93	41	1.081	0.797
The lack of knowledge about IR limits its advantages	3.55	11	1.128	3.63	30	1.273	3.61	41	1.222	0.841
The role of IR is still in the beginning and needs to be improved	3	1		3.61	23	0.988	3.58	24	0.974	0.553
I see the future for IR methods	4	1		3.39	23	1.118	3.42	24	1.1	0.599

Abbreviations: M, Mean; N, Number of respondents; SD, Standard deviation; Sig, Statistical significance.

Table 5 The Frequency Levels of IR Applications in Different CT Exams According to the Participants' Responses

	Frequency (Percent)/n (%)				
CT Scan Cases	**Never**	**Rarely**	**Sometimes**	**Most of the Time**	**Always**
Emergency and trauma patients scans:	4 (9.8%)	7 (17.1%)	11 (26.8%)	6 (14.6%)	13 (31.7%)
CT studies for pediatric patients	3 (7.3%)	6 (14.6%)	8 (19.5%)	5 (12.2%)	18 (43.9%)
CT scans of neurologic patients	2 (4.9%)	7 (17.1%)	10 (24.4%)	8 (19.5%)	13 (31.7%)
Follow up CT scan protocols	1 (2.4%)	4 (9.8%)	11 (26.8%)	11 (26.8%)	13 (31.7%)
Orthopedic examinations CT scan protocols	3 (7.3%)	5 (12.2%)	13 (31.7%)	5 (12.2%)	14 (34.1%)
CT scan protocols of angiography examinations CT scan	3 (7.3%)	3 (7.3%)	13 (31.7%)	9 (22%)	12 (29.3%)
CT scan studies of female patients particularly the expected pregnant	6 (14.6%)	6 (14.6%)	7 (17.1%)	9 (22%)	12 (29.3%)

on the importance of the IR technique for all listed scan cases, some participants stated that IR was never or rarely used in those examinations. Radiologists and radiographers had almost similar responses regarding the use of IR techniques for various CT scan exams, and there were insignificant differences between them ($p > 0.2$). They mostly agreed that the IR technique is applied in various CT scan examinations. This may reflect their awareness of the advantages of IR. They all have similar opinions on IR application, as there were insignificant differences between them ($p > 0.2$).

For the open questions at the end of the survey, the results showed that 50% of the participants (28 respondents) were not involved in the updating process of CT protocol. Seventy-three percent of them appreciated the use of IR methods for different reasons. Most of the respondents stated that they use IR most of the time or always for CT exams (32 and 37%, respectively). Some participants (33.3%) recommended using IR for almost all CT examinations.

Discussion

This research was conducted using a questionnaire to evaluate radiographers' and radiologists' perceptions about IR, and their practices with this technique for the last two months. The questionnaire included four sections, followed by four open-ended questions that allowed the participants to freely reflect on their own experiences and opinions regarding IR. The IR technique is a widely used technique for diagnosing defects in various parts of the body due to its authentic and safe results compared to other techniques. The survey collected information about IR dose usage according to patient age and weight.

The circumstances that control specific IR strength levels or percentages are most likely unclear. Also, the IR percentage was not determined based on the type of CT examination. The dominant IR strength level was 50%, chosen frequently and commonly in each case. It seemed that this IR strength level was determined previously as the default selection by the manufacturer, and they (radiologists and radiographers) were using this for all CT scan protocols. The results show vast differences between different groups (radiologists and radiographers). Although the result shows significant differences ($p < 0.001$) in terms of the selected IR strength level, it seemed that the factor of CT examinations was not evident in the selection of IR percentage.

A 50% IR strength level l was selected by 81.1% of the participants for the CT of the patients with different weights. The result shows insignificant differences ($p > 0.877$) regarding patient weight in selecting strength levels. Therefore, the factor of patient weight was not a parameter that would be considered for IR strength level l selection. The role of radiographers and radiologists in selecting an appropriate percentage of IR strength levels may be missing, or at least ineffective.

Based on the survey studies, most of the respondents (46.4%) did not obtain theoretical knowledge about IR and some (26.4%) were not sure about this. Moreover, a minority of them (12%) have received formal training in IR. Meanwhile, half of the respondents generally stated that they were not involved in CT scan protocol training.

The research concluded that without proper training and involvement of radiographers and radiologists in CT protocols, they were unable to apply different techniques and modulate different parameters according to situations. For example, studies have revealed that tube current should be modulated according to patient body size during scans.[22] The IR percentage should also be adjusted according to the exam type and part of the body whose scan must be done. Apprehending the IR technique by radiographers and radiologists would benefit patients' health and make disease diagnosis more effective and accurate.

Most of the participants agreed that the rotation time, mAs, and kVp values would be adjusted according to patient size for diagnostic purposes. Surprisingly, more than half of the respondents (53.5%) agreed to decrease kVp according to the patient size for diagnostic purposes. Even though most respondents (58%) agreed to use thicker slices for diagnostic purposes, as thinner slices lead to higher radiation, slightly less than half of the participants agreed with the opposite results. Forty-four percent agreed that "the thicker slices lead to higher radiation." For the two statements regarding increasing or decreasing kVp values according to contrast media density, only 24 participants responded. They seemed likelier to be neutral or disagree (mean 2.63, n=24). Most of the responded participants generally agreed (62.5% out of 24 participants who responded) with applying IR methods whenever appropriate.

Generally, the radiologists and radiographers had similar agreement levels with each statement regarding strategies of image quality optimization, and there were insignificant differences between them ($p > 0.05$). One exception to this was a significant difference ($p < 0.009$) between them, as radiographers strongly disagreed with using AEC during head CT scans, but the radiologists most likely agreed with this statement (mean 3.61, n=23).

A recent study evaluated the influence of the IR technique and its strength level on the optimization of image quality and the reduction of radiation dose in pulmonary angiography CT.[23] The same study found that image quality can be significantly improved by increasing IR strength level and lowering kVp in small body patients.

Almost half of the participants agreed on the importance of the IR technique for all listed scan cases. Some participants stated that IR was never or rarely used in those examinations. Radiologists and radiographers had almost similar responses, as there were insignificant differences between them ($p > 0.2$).

The SPSS analysis results showed that radiologists and radiographers had almost similar responses regarding IR techniques for various CT scan exams. Almost all agreed that the IR technique has been more significant and accurate for various scans over many years. They all have almost the same opinion on IR application, as there were insignificant differences between them ($p > 0.2$).

For the open questions at the end of the survey, the results show that 50% of the participants who responded (28 participants) to the questions were not involved in the updating process of the CT protocol. Seventy-three percent of them appreciated the use of IR methods for different reasons. Most of the participants (19 participants) stated that they always used IR for CT exams. Some participants (33.3%) recommended using IR for almost all CT examinations.

Conclusion

The results indicate that the majority of radiographers and radiologists have no explicit or authentic knowledge about IR strength level selection for the scanning process. We concluded that, without proper training and the involvement of radiographers and radiologists in CT protocols, they could not apply different techniques and modulate different parameters according to situations.

There is a need to conduct training sessions to improve their performance and understanding of image quality optimization and radiation dose reduction. If participants (radiographers and radiologists) have expertise with this technique, this will benefit the patient's health, and disease diagnosis will be made effectively and accurately. Further studies are required to adjust CT protocols to effectively utilize the IR technique and its strength levels to optimize the image quality of CT examinations.

Ethics Approval

This study was approved by IRB committee at King Fahad Specialist Hospital (KFSH) ministry of health (MOH), reference number is: EXT0360. The study complies with the Declaration of Helsinki.

Consent

The informed consent was obtained from the study participants. All participants agreed to contribute at the research.

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Disclosure

The authors report no conflicts of interest for this work and declare no conflict of interest in preparing this article.

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