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Medical Student's Knowledge of Ionizing Radiation and Radiation Protection in Riyadh, Saudi Arabia

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ABSTRACT

Objectives: This study aimed to assess the knowledge of medical students in ionizing radiation and to study the effect of a 3-hour lecture in correcting their misconceptions.

Methods: a cohort study was conducted on medical students at Almaarefa Colleges, Riyadh, Kingdom of Saudi Arabia during the academic year 2015-2016. A 7-question multiple choice test type questionnaires administered before and after a 3-hour lecture was used to assess their knowledge. The data were collected from December 2015 to February 2016. The lecture was given to 333 (72%) participants, out of the total of 459 medical students. It covered topics in ionizing radiation and radiation protection. The questionnaire was validated and analyzed by 3 content experts. **Results:** of the 333 who attended the lecture, only 253 (76%) students completed the pre- and post questionnaire and they were included in this study. The average student score improved from 47-78% representing a gain of 31% in knowledge (p =0.01).

Conclusion: the results indicated that the medical student's knowledge regarding ionizing radiation and radiation protection is inadequate. Additional lectures in radiation protection significantly improved their knowledge of the topic and correct their current misunderstanding. This study had shown that even with one dedicated lecture, students can learn and learn general principles regarding ionizing radiation.

Keywords: ionizing, non-ionizing ,radiation, students, lecture

INTRODUCTION

Radiological investigations have been widely used in patient management and these investigations involved exposing the patients to either ionizing, or non-ionizing radiation. The number of investigations involving ionizing radiation has dramatically increased in the past decade. It was estimated that CT examinations have increased in the USA by a factor of 10 from 1980-2005[1]. In the USA, CT examinations account for 13% of all diagnostic exposure, but it was estimated to be responsible for more than 70% of the collective radiation dose delivered to patients [2]. Advancement in technology has led to complex interventional radiological procedures and nuclear medicine investigations. With these advancements, concerns regarding radiation dose to patients arise. Although most of these exposures were justified, not all of them were clinically useful. Today, patients are more aware that radiation can be harmful. During medical exposure from examinations involving radiation, doctors are the main source of information. They have to be prepared and aware of the risks, benefits and dose in order to provide an accurate explanation to their patients. Doctor's justification of diagnostic imaging requests depends on their experience and knowledge of radiation doses of these investigations. This has been of concern among faculty members in charge of undergraduate medical students, since this knowledge should already be developed at the undergraduate level [3-5]. Since 1989 and up to date, several studies were questioning medical student's knowledge related to ionizing radiation and more research has been conducted on the topic. Some of them found that student's knowledge of radiation safety is insufficient and hundreds of unnecessary examinations are performed every year due to this lack of knowledge. They have emphasized that radiation protection should be mandatory and part of the medical school curriculum [3-10].All these disappointing results urged **O'Sullivan *et al*.** [11] to investigate the effect of a curriculum in clinical radiology that included radiation protection. They assessed the awareness of all medical students (from years 1-5) of radiation exposure and studied the effect of clinical radiology curriculum on their knowledge. They used a questionnaire that assessed radiation knowledge and radiology teaching. First year medical student on their first week of classes was used as a control group. Improvement in knowledge was found year after year in comparison with the control group. They concluded that those who received radiology teaching (87%) performed better than those who did not. But, still only 60% of the population knew that CT used ionizing radiation

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and approximately 25% still believed that magnetic resonance imaging (MRI) was the only used ionizing radiation. They concluded that all medical schools should implement radiation protection instruction as part of the undergraduate medical curriculum[11]. This study aimed to assess the knowledge of medical students at Almaarefa Colleges in Riyadh, Kingdom of Saudi Arabia (KSA) in ionizing radiation and to study the effect of a 3-hour lecture as part of their radiology module on that knowledge.

METHODS

Lecture. The undergraduate medical students during their years of clinical teaching are exposed to a 30-hour medical imaging module. Part of this module is dedicated to principles of ionizing radiation and radiation protection. A 3-hour lecture covering materials on diagnostic procedures that use ionizing and non-ionizing radiation, as well as radiation protection principles was given from December 2015 to February 2016 to male and female students of Almaarefa Colleges, Riyadh, KSA. The outline of this lecture was shown in **Table 1. Questionnaire**. A modified version of a previously published questionnaire[4] in the format of a multiple-choice test was used to assess the knowledge of medical students **(Table 2).** It tested the student's knowledge regarding diagnostic procedures, such as CT and MRI. In addition, it included questions on radiation protection and basic principles of ionizing radiation. 3 radiologists confirmed the validity of this questionnaire and reliability was determined by Cronbach alpha (0.83). These content experts (who teach and train medical students during their clinical rotations) rated the importance of each of the 7 questions to the core knowledge required before graduation. They all agreed that questions 1, 2 and 4 were core knowledge and the medical students must know the answer for them to move on to the next year. In addition, 2 of the contents expert thought that questions 3, 6 and 7 were core knowledge, however, only 1 of them felt that knowing the international standard (SI) unit for measuring radioactivity was important at this stage. Subjects. The cohort consisted of undergraduate medical students at Almaarefa Colleges who attended the lecture. The questionnaire was administered before and after the lecture. Two questionnaires were collected for each student. Students who did not provide both pre- and post completed questionnaires were excluded from this study. The approval was obtained from the Local Ethics Committee at Almaarefa Colleges to conduct this study. Data were entered and analyzed using the Statistical Package for Social Sciences version 19 (SPSS Inc, Chicago, IL, USA). Pearson correlation coefficient was carried out to study correlation between variables. $P<0.05$ was considered significant.

RESULTS

Out of the 459 medical students at Almaarefa Colleges in 2016, 333 (72%) attended the-3 hour lecture. Of those, 253 (76%) participated in the post-lecture test and represented the study population. Among these students, 126 (49.8%) were female, and 127 (50.2%) were male. Two questionnaires were collected for each participant, that was pre- and post lecture. Correct answers were given one mark each, while the incorrect ones, or omissions received a mark of zero. A total score was given to each student before and after the lecture. **Table 2** showed the 253 students answers on the 7 questions, pre- and post lecture. Improvement in test score was found in all questions, except question 2, "Intravenous contrast material used in angiogram is radioactive". This was not one of the topics covered in the lecture due to lack of time. We assumed that the student's first answer to this question was a presumption and the second represents what they really know about it (only 26% knew the correct answer). The average test score improvement was calculated from subtracting pre-lecture score from post-lecture score for each question. Since content facts for the second question was not covered in the lecture, test score improvement for that question could not be measured. Therefore, question 2 was excluded from this analysis. Higher post-test score that varied between 19-83% represented improvement in all other questions. For the entire study, the average student score improved from 47-78%, representing a gain in knowledge of 31% ($p=0.01$). The results above suggested a highly significant effect of the 3-hour lecture in correcting the misconceptions of students prior to the lecture. On the pre-lecture questionnaire, only 44 (17%) students scored above 60%, which was the passing grade. Among those students, only 6 (3%) scored 86, which was the highest score. Four students got a zero on the pre-test. Furthermore, 40% of the students thought that objects in the room would still emit radiation after completion of exposure. The dose from CT procedures was under estimated by 30% of the students. In addition, only 47% of the students knew that MRI does not involve ionizing radiation. On the post-test, 219 (87%) students scored above the passing grade. Among these, 23 students scored a full mark of 100. Only 3 students (30%) scored the lowest grade on the post-test. When comparing the before lecture knowledge of female to male students, the average score was 43% for female, and 51% for male. **Figures 1 & 2** showed the improvement in test scores for both male and female, which was significant (p=0.028). The average test score improvement was 35% for females and 26.6% for males. Improvement in the test scores was documented for female students in questions 1, 4, 6, and 7, higher than that of the male students. On the other hand, improvement for male students in questions 3 and 5 were higher than that for female students (Figure 3). The results suggested that female students benefited slightly more from the 3-hour lecture. Also, the pre-lecture knowledge of male students was higher than that of female students on questions 1, 3, 4 and 6.

Table 1 Outline of the lecture.

No of slides for each topic	Topic
1-5t	Types of radiation, and difference between ,ionizing and non-ionizing radiation
6-9	Interaction of radiation with matter
10-14	Radioactivity and half-life
15-28	Radiological diagnostic procedures that useionizing radiation
29-34	Awareness of the level of radiation that patients are exposed to during radiological investigation
35-52w	Radiation protection principles
53-54	Radiosensitivity
55-60	Risk associated with each type of investigation
60-68	Image quality versus dose
69-80	Personal monitoring device for radiation safety
81-91	Shielding and monitoring equipment
92-96	Role of a medical physicist in diagnostic and therapeutic radiology

Table 2 - Students response to the 7 questions pre- and post lecture.

Questions	Pre	Post (%)	*P*-value
Q1			0.000
Incorrect	99 (39.0)	34 (13.0)	
Correct	154 (61.0)	219 (87.0)	
Q2			
Incorrect	162 (64.0)	188 (74.0)	NA*
Correct	91 (36.0)	65 (26.0)	
Q3			
Incorrect	106 (42.0)	16 (6.0)	0.003
Correct	147 (58.0)	237 (94.0)	
Q4			
Incorrect	72 (29.0)	24 (10.0)	0.028
Correct	181 (71.0)	229 (90.0)	
Q5			
Incorrect	223 (88.0)	13 (5.0)	0.000
Correct	30 (12.0)	240 (95.0)	
Q6			
Incorrect	133 (53.0)	43 (17.0)	0.001
Correct	120 (47.0)	210 (83.0)	
Q7			0.000
Incorrect	145 (57.0)	76 (30.0)	
Correct	108 (43.0)	177 (70.0)	

NA - not applicable because incorrect answers of the post-lecture test were more than those in the pre-lecture test

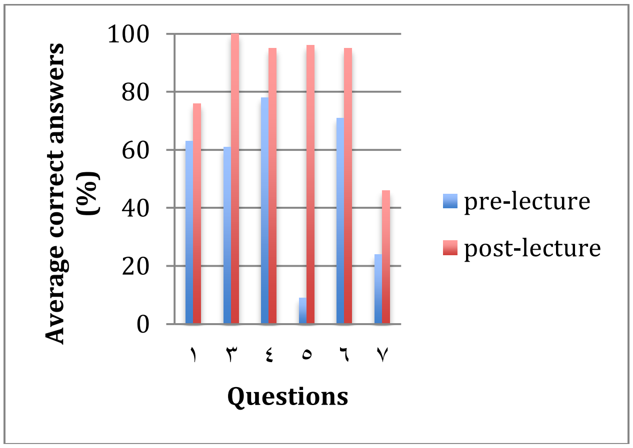


Figure 1: Data represents the average percentages of correct answers for question 1, 3, 4, 5, 6, and 7, pre- and post lecture for male students.

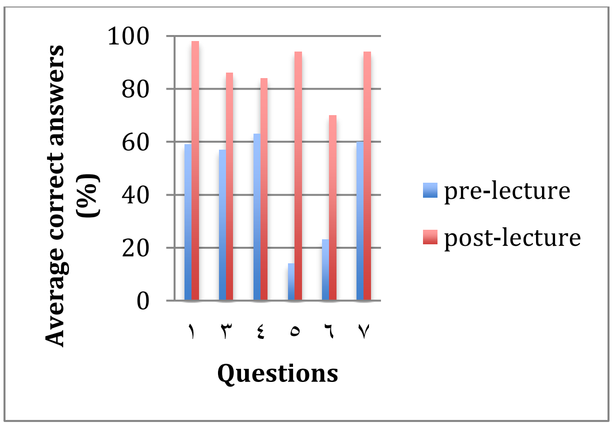
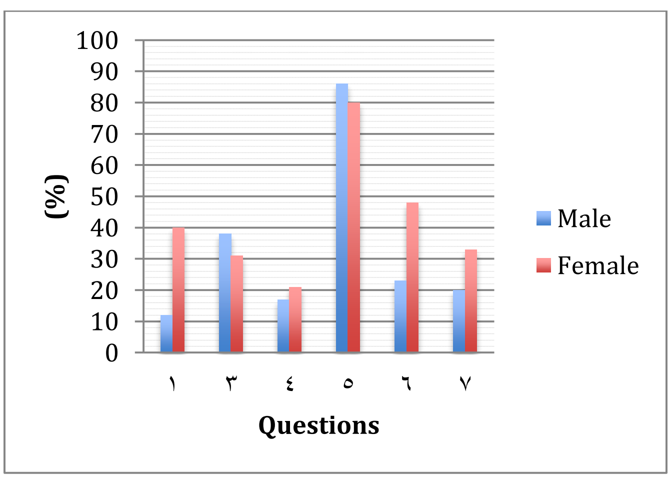


Figure 2: Data represents the average percentages of correct answers for question 1, 3, 4, 5, 6, and 7, pre- and post lecture for female students.



Figures 3: Data represents the average percentages of test score improvement for question 1, 3, 4, 5, 6, and 7 for female and male students

DISCUSSION

The use of x-ray in diagnostic radiology requires good practice, as well as proper knowledge of dose associated with all types of procedures. The International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) established guidelines for the safe application of all types of radiological procedures and personnel safety. Extensive literature review revealed that there was a worldwide concern regarding how much doctors know on this topic. Several publications proved that the knowledge of medical students on ionizing radiation and radiation protection is very poor [4,6,11].

It was reported that interns have avoided accompanying patients in need of medical support during radiological examinations, furthermore pregnant female interns worried of their well-being, have avoided walking through the radiology department. In addition, some medical students avoid standing in the control console area during a radiological exposure worried of the dose in that area [9].

All this is a reflection of knowledge deficiency among future doctors. This study demonstrated that medical students have a shortage of knowledge with regard to ionizing radiation, diagnostic imaging and radiation safety. Findings from the present study agree with those of **Mubeen *et al.*** [4], which showed that approximately 40% of their student population believed that objects in the x-ray room emit radiation after an x-ray procedure. Their study showed that 18% of the students thought that MRI involved ionizing radiation. The present investigation at Almaarefa Colleges, documented that nearly 50% of the students thought that MRI involves ionizing radiation and 28% underestimated the dose from CT scan. In addition, 60% of them were not sure of the radiosensitivity of the human body organ with regard to radiation. Differences in knowledge level among genders were reported in 2007 by **Arslanoglu *et al.*** [8].

They have found that female students had slightly lower knowledge with regard to ionizing radiation demonstrated in their overall score of 42%, while male students scored 57%. Similarly, the conducted study confirmed that female students scored 43%, while male students were 51% on the pre-lecture questionnaire. The slightly lower score reported for female students shifted on the post-lecture questionnaire to show improvement in knowledge (35%) compared to 26% for male students. However, these differences were not statistically significant. Both female and male student's knowledge improved in all questions with the exception of question number 2. The findings of the present study re-enforces the importance of adjustments to medical students curriculum and emphasized that radiation protection should be taught as a priority to improve future clinician's knowledge[10].

A weakness of this study was that the intended topics related to the questionnaire could not be fully covered within 3 hours. Therefore, it was recommended to the module coordinator at Almaarefa Colleges to increase the teaching time to 6 hours (that is, 2 lectures) and approval was granted for the next academic year. Time between the lecture and the post questionnaire was intended to be as close as possible to assess only the lecture effect. The whole module including the clinical rotation in radiology could have an impact on student's knowledge and can be measured 4-weeks later using a third questionnaire administered after the completion of imaging module. In conclusion, it has been documented that medical students worldwide have a shortage of knowledge with regard to ionizing radiation, diagnostic imaging and radiation safety. Therefore, this gap in knowledge should be taken into consideration when designing undergraduate curriculum. The findings from the present study emphasizes that radiation protection should be taught as a priority to improve future clinician's knowledge.

CONCLUSION

This study provided evidence that additional lecture in radiation protection and ionizing radiation significantly improved the medical student's knowledge of the topic. Consequently, this resulted in improving health service quality by minimizing patient exposure dose and providing proper patient education. Further investigations are required to determine the optimum method of improving medical students and current referring doctor's knowledge of radiation protection.

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