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ORIGINAL ARTICLE

Current attitudes of Turkish anesthesiologists to radiation exposure

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Abstract
Purpose The aim of this study was to investigate the attitudes of anesthesiologists to radiation exposure and current safety practice in Turkey.
Methods The study enrolled anesthesiologists from all over Turkey, including all levels of academic degrees and all types of different institutions. Questionnaire forms were sent via e-mail to 505 anesthesiologists. The survey collected demographic data such as age, gender, position, and the institution at which the participant worked, and data about the frequency of radiation exposure during procedures and the participant's attitudes concerning radiation safety measures during these procedures.
Results The questionnaire forms were delivered to 491 anesthesiologists, and 301 (61.3 %) of these were returned. Of these, 9 had not completed the questionnaire because of a lack of exposure to radiation. Among the remaining 292 personnel, the weekly frequencies of radiation exposure were more than five times (36.7 %), one to five times (50.3 %), and less than once (13 %) per week, respectively. Only a few anesthesiologists regularly wore a lead apron (30.11 %) and a thyroid shield (11.3 %) during procedures involving radiation exposure.
Conclusions This study demonstrated that nearly all anesthesiologists are regularly exposed to radiation and that few anesthesiologists in Turkey wear protective clothing, which is essential for radiation protection. Therefore, if it is not, increasing awareness about radiation protection should be an integral part of medical training and education.

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Introduction

Radiation exposure at any dose can have deleterious effects [1–8]. Radiation-dependent surgical interventions are gradually increasing in many areas (e.g., orthopedics, neurosurgery, urology, pediatrics, radiology, cardiology, vascular surgery, and pain management). Consequently, operating rooms have become fields for exposure to radiation, with the risk of radiation exposure greatest among anesthesiologists [9–11]. However, the dose of radiation exposure faced by anesthesiologists has not been studied extensively. Protective measures and relevant habits adopted by anesthesiologists to guard against radiation exposure are inadequate. The aim of this study was to investigate the attitudes of anesthesiologists to radiation exposure and current safety practice in Turkey.

Materials and methods

The study enrolled anesthesiologists from all over Turkey, including participants working in universities, in state and private hospitals as residents, anesthesiologists, professors, and assistant or associate professors. After obtaining the approval of the ethics committee of the Dicle University Faculty of Medicine, questionnaire forms were e-mailed to 505 anesthesiologists in May 2012. The identity of the respondents was not disclosed. The questionnaire was anonymous, self-administered, and nonvalidated in design. Demographic data such as age, gender, academic level of the participants, number of working years, and place of

work were recorded. In the second part of the survey, the participants answered questions about the clinics in which they had been exposed to the radiation, measures they had taken to protect themselves against the radiation, and their attitudes to the exposure. Responses to questions inquiring about the frequency of implementation of protective measures against radiation exposure were expressed as "never," "rarely," "usually," and "always." Two weeks after the reminder period, all the data were transferred to a computerized database and organized for statistical evaluation. At the end of the data collection period, an e-mail was sent to all the participants thanking them for their cooperation.

For the statistical analysis of the data, the SPSS software program (SPSS, Chicago, IL, USA) was used. All the data were expressed as the mean ± SD or as *n* (%). Frequency analyses were performed for all the numerical data, and the chi-square test was used for categorical variable comparison. Correlation analysis was performed with Pearson's test. $P < 0.05$ was considered to be significant.

Results

The questionnaire forms were delivered to 491 anesthesiologists, and 301 (61.3 %) participants completed the forms. Nine participants indicated that anesthesiologists were not involved in procedures involving radiation exposure in their healthcare organizations. The mean age of the 292 (97 %) anesthesiologists who reported radiation exposure was 39.8 ± 7.3 years. The demographic characteristics of the participants are shown in Table 1.

The most common means of protection was the use of lead aprons. However, only a few (30.11 %) of the anesthesiologists always wore these aprons, and 11.3 % always used thyroid shields during the procedures. All those who wore a lead apron also used a thyroid shield. However, only slightly more than half (54.1 %) of those who used a thyroid shield also used a lead apron. Only 9 % of the anesthesiologists used dosimeters. The attitudes of the anesthesiologists toward radiation exposure are summarized in Table 2.

Rates of habitual lead apron use were similar among male and female anesthesiologists ($p > 0.05$). However, with an increasing number of years spent in anesthesiology practice, the frequency of lead apron use increased proportionally ($p = 0.006$). In addition, according to the position of the habitual lead apron users in anesthesia practice, professors reported the highest rates and residents reported the lowest (43.3 % and 5.1 %, respectively). An increasing rate of wearing protective measures was detected with an increase in the frequency of radiation exposure ($p = 0.001$) (Table 3).

The most common motive for radiation protection was fear of cancer ($n = 137$): concerns about having a baby with an anomaly were more frequently expressed by females (men, 4.8 %; women, 18.1 %). The most common reason for not using radiation shields was their nonergonomic design (Table 4).

Table 1 Distribution of study participants according to descriptive features

Status	*n* (M/F)	Age (years)	Institution			
			University hospital	Education and research hospital	State hospital	Private hospital
Resident	29/10	31.3 ± 3.3	36	3	0	0
Specialist	69/88	39.8 ± 6.4	13	46	48	50
Assist. Prof.	27/13	38.7 ± 5	36	4	0	0
Assoc. Prof.	10/16	42 ± 3.4	22	3	1	0
Prof.	11/19	50.5 ± 6.1	28	1	0	1
Total	292	39.8 ± 7.3	135	57	49	51

Data are given as mean ± SD or *n*

M male, *F* female, *Assist.* assistant, *Assoc.* associate, *Prof.* professor

Table 2 Attitudes of anesthesiologists concerning radiation exposure

	Number of returns	Never (*n*, %)	Rarely (*n*, %)	Usually (*n*, %)	Always (*n*, %)
Lead apron	292	24 (8.2 %)	68 (23.3 %)	112 (38.4 %)	88 (30.1 %)
Thyroid shields	291	108 (37.1 %)	87 (29.9 %)	63 (21.6 %)	33 (11.3 %)
Dosimeter	290	264 (91.0 %)	8 (2.8 %)	10 (3.4 %)	8 (2.8 %)

Table 3 Correlation analysis of attitudes of anesthesiologists against radiation exposure with their demographic characteristics ($n = 292$)

	Never (n, %)	Rarely (n, %)	Usually (n, %)	Always (n, %)	p value
Gender					
Male	11 (7.6)	35 (24)	57 (39)	43 (29.4)	0.959
Female	13 (8.8)	33 (22.6)	55 (39.8)	45 (30.8)	
Years in anesthesia practice (years)					
<4	3 (8.1)	15 (40.5)	17 (45.9)	2 (5.4)	
5–10	2 (7.7)	6 (23.1)	13 (50)	5 (19.2)	**0.006**
>10	19 (8.2)	47 (20.5)	82 (35.8)	81 (35.4)	
Academic title					
Resident	4 (10.2)	16 (41)	17 (43.6)	2 (5.1)	
Specialist	14 (8.9)	37 (23.6)	58 (36.9)	48 (30.6)	**0.020**
Assistant professor	3 (7.5)	8 (20)	12 (30)	17 (42.5)	
Associate professor	2 (7.7)	5 (19.2)	11 (42.3)	8 (30.7)	
Professor	1 (3.3)	2 (6.7)	14 (46.6)	13 (43.3)	
Frequency of radiation exposure (times/per week)					
>5	1 (2.6)	1 (2.6)	17 (44.7)	19 (50)	
1–5	11 (7.5)	34 (23.1)	54 (36.7)	48 (32.6)	**0.001**
<1	12 (11.2)	33 (30.8)	41 (38.3)	21 (19.6)	

Table 4 Anesthesiologists' reasons for using radiation shielding or clothing

Reasons for using	n	Reasons for not using	n[a]
Concerns about contracting cancer	137	Leaving room during image taking	143
My training routines and habits	79	Protective clothes are not ergonomic: heavy, rigid, etc.	99
Concerns about having a baby with an anomaly	33	Protective clothes are not practical: put on, hang up, etc.	94
I am not concerned	28	Protective clothing is not available	52
Concerns about infertility	14	I don't believe that it has a protective effect against radiation	32

[a] The participants were allowed to give more than one answer to this question

Discussion

The present study demonstrated that the frequency of regular exposure of radiation among anesthesiologists is very high in Turkey but that the use of protective measures is relatively low.

Occupational radiation exposure is increasing in frequency in line with the widespread use of radiation during diagnostic and therapeutic procedures. Increased employment of radiation during surgical and interventional procedures places accompanying anesthesiologists at risk. Only 3 % ($n = 9$) of the anesthesiologists surveyed reported that they had not been involved in radiation-dependent procedures in their institutes. All the remaining participants reported that they had been exposed to radiation during operations performed in almost all disciplines, most frequently during orthopedic, urological, and neurosurgical interventions. This is a worldwide phenomenon. In some procedures, anesthesiologists are exposed to higher radiation doses than surgeons or radiologists [12]. The majority of the participants (87 %) in the present study indicated that they took part in more than one radiation-dependent procedure in a week. The frequency of exposure decreased with the years spent in anesthesia practice and the academic status of the anesthesiologist. As higher academic status requires the existence of many sub-branches of anesthesia, professors are not present in every operating room, which reminds us that residents probably work in different operating rooms. We think that training courses in radiation exposure protection would be an appropriate component of their educational curriculum.

As a consequence of continuous radiation exposure, healthcare workers are especially vulnerable to both its cytotoxic and stochastic effects. The Health Physics Society has stated that the determination of individual risk should only be done at radiation exposures above 50 mSv in 1 year or 100 mSv lifetimes. However, the "as low as reasonably achievable" (ALARA) principle is accepted as a gold standard [13]. Protective measures against radiation exposure can be placed into three main categories related

to the duration of the exposure, the distance away from the ionizing radiation, and the use of radiation-shielding clothing [14]. The radiation dose absorbed increases in accordance with a rise in the duration of the radiation exposure. The amount of radiation dose exposure dramatically decreases in proportion with the square of the distance away from the source of the radiation. The most efficient method of protecting against radiation emitted from external sources is the use of body armor. Lead-containing materials are used for this purpose in the field of medical procedures. Although the effectiveness of these materials has been acknowledged [15, 16], their protective capacity depends on whether individuals are in the habit of using them. A few studies have investigated physicians' habits of using lead-containing materials to combat radiation exposure. In one such study performed with urologists, Soylemez et al. [17] reported that the incidence of lead apron and thyroid shield use among their colleagues was very low (75 % and 46 %, respectively). Another study reported that only 4 % of orthopedicians routinely used thyroid shields [18]. A Californian survey conducted with radiology department workers showed that 70.5 % of the participants routinely used protective measures [19]. Unfortunately, the present study revealed very low levels of routine lead apron and thyroid shield use among anesthesiologists (30 % and 11 %, respectively). Previous studies and the current investigation clearly reveal that the application of protective measures by healthcare personnel has not reached the desired level.

Although leaving the room during image taking was used as a protective measure, it may cause malpractices. Therefore, standard protective measures should be implemented. The most frequently cited reason for not using protective garments was their impractical and nonergonomic features. In fact, problems while using these garments have been reported during orthopedic procedures (cardiologists, radiologists, urologists, etc.) [20–22]. We hope that garments with an improved ergonomic design and better radiation protective properties will be introduced into common use.

The use of a dosimeter has been recommended for those who are regularly exposed to radiation. However, only up to 50 % of healthcare personnel exposed to radiation use dosimeters [23]. One study reported that only 3 % of urologists were routinely using dosimeters [17]. Radiation monitoring using dosimeters is advised if the employee is likely to receive >10 % of the annual limit. In the present study, 3 % of the participants were using dosimeters. The present study lacks exact radiation doses for the participants. Monitoring anesthesiologists for radiation exposure, with and without lead aprons, might have improved the safety analysis.

The results of the current study demonstrated that anesthesiologists in Turkey are not sufficiently aware of radiation exposure. Deficient knowledge about radiation protection might stem from inadequacy of relevant information and training. In a study of 120 clinicians, Quinn et al. [24] demonstrated that the knowledge and responsiveness of the participants regarding radiation increased following provision of the required training. According to the outcomes of the present study, neglectful behavior related to radiation exposure and protection is more evident during the internship years. Therefore, information on the importance of radiation protection should be a part of medical training.

Conclusion

The current study demonstrated that nearly all anesthesiologists had some radiation exposure from medical sources. The second and the most important result of the study is that anesthesiologists are using protective clothing at a very low rate. Therefore, increasing awareness about radiation protection should be an integral part of medical training and education. Future studies performed in different countries will provide us with further insight.

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Conflict of interest None.

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