Turkish Pediatric Surgeons Knowledge on the Radiation Exposure of Patients During Diagnostic Imaging

Tanısal Görüntüleme Yöntemleri Sırasında Hastaların Maruz Kaldıkları Radyasyon Dozu Hakkında Türk Çocuk Cerrahlarının Bilgi Düzeyi

Cesur GÜMÜŞ, MD,[a]
Levent CANKORKMAZ, MD,[b]
M. Fatih ERKOÇ, MD,[a]
Bilge ÖZTOPRAK, MD,[a]
Mehmet ATALAR, MD,[a]
Gökhan KÖYLÜOĞLU, MD[b]

Departments of [a]Radiology,
[b]Pediatric Surgery,
Cumhuriyet University
School of Medicine, Sivas

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Yazışma Adresi/*Correspondence:*
Cesur GÜMÜŞ, MD
Cumhuriyet University
School of Medicine,
Department of Radiology, Sivas
TÜRKİYE/TURKEY
cgumus@cumhuriyet.edu.tr

ABSTRACT Objective: To investigate the level of pediatric surgeons information about patients' radiation exposure doses during radiological examinations such as radiography, computed tomography (CT). **Material and Methods:** A questionnaire of demographic data (academic title, experience, and foundation) and a questionnaire of knowledge of radiation exposure doses were administered to 102 pediatric surgeons. Chi-square test was used in the statistically evaluation. **Results:** 73.5% of the participant were underestimated radiation exposure for an abdominopelvic CT examinations. Some pediatric surgeons were not aware that magnetic resonance imaging (21.6%) and ultrasound (10.8%) are radiation free imaging. The question for the lifetime increased cancer risk because of radiation from one abdominal and pelvic CT scan was answered as yes by 49 (48%) pediatric surgeons, and no by 53 (52%) pediatric surgeons. The life time risk of cancer for one abdominopelvic CT was falsely answered by the majority of pediatric surgeons. The frequency of discussion of this risk with patient and families was too low. There were statistically no difference between the demographic data and knowledge base section for all parameters of the questioners. **Conclusion:** We have determined a lack of information about radiation exposure for diagnostic imaging in the Turkish pediatric surgeon population.

Key Words: Radiation dosage; diagnostic imaging; magnetic resonance imaging; ultrasonography; tomography scanners, x-ray computed

ÖZET Amaç: Çocuk cerrahların radyografi, bilgisayarlı tomografi (BT) gibi radyolojik incelemelerde hastanın aldığı radyasyon dozuna ait bilgi düzeylerinin belirlenmesidir. **Gereç ve Yöntemler:** 102 pediatrik cerraha demografik verileri (akademik unvan, tecrübe süresi ve kurum) ve radyasyon dozu hakkında bilgi düzeylerini sorgulayan birer anket yapıldı. İstatistiksel değerlendirilmede χ^2 testi kullanıldı. **Bulgular:** Abdominopelvik bir BT de alınan radyasyon dozu hakkında doğru yaklaşım katılımcıların %16.7'si tarafından yapılmış olup %73.5'i normalden düşük olarak belirtmiştir. Bazı çocuk cerrahları manyetik rezonans görüntüleme (%21.6) ve ultrasonografi (%10.8)'nin radyasyondan bağımsız olduklarından habersizdi. Bir abdominal ve pelvik BT'den dolayı artmış hayat boyu kanser riski sorusuna 49 (%48) tanesi evet 53 (%52) tanesi hayır cevabını verdi. Çocuk cerrahlarının büyük kısmı bir abdominal ve pelvik bir BT'den dolayı kanser risk artış değerine yanlış cevap vermişlerdir. Bu riskin hasta ve aileleriyle tartışılma oranı ise oldukça düşük çıkmıştır. Anketin tüm alanlarındaki sorularla ve demografik veriler arasında anlamlı bir farklılık çıkmamıştır. **Sonuç:** Türk çocuk cerrahlarında tanısal görüntülemede alınan radyasyon dozu miktarı hakkında bilgi eksikliği olduğu belirlenmiştir.

Anahtar Kelimeler: Radyasyon doz; tanısal görüntüleme; manyetik rezonans görüntüleme; ultrasonografi; bilgisayarlı tomografi

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Imaging studies that use ionizing radiation are essential tools for the evaluation of many disorders of childhood.[1] There are potential risks in addition to the clear potential benefits in medical interventions. Its

potential for harm has been demonstrated by the deaths of early radiation workers, and follow-up studies of patient groups exposed to repeated or high-dose radiological investigations.[2-5]

Several expert bodies, including the National Cancer Institute, have also developed consensus statements and guidance for clinicians. Pediatric surgeons as well as radiologists have an important role in guiding the proper use of diagnostic imaging in children, and the surgeon in concert with the radiologist ultimately decides whether an examination including ionizing radiation is indicated. With this role comes a responsibility to recognize the potential risks. To date, there is limited published experience for clinicians' awareness on potential cancer risks, and peer assessment is essential to guide continuing education for these issues.[6] Previous investigations proved that doctors had inadequate knowledge on radiation safety and consequently hundreds of unnecessary examinations are performed every year.[7,8]

The aim of our study was to investigate a large cohort of pediatric surgeons to establish the level of information on the radiation doses and risks associated with radiological investigations in children. Questions were also included on radiation protection, the issue of informed consent and the sources and level of educational input during pediatric surgery training.

MATERIAL AND METHODS

A simple questionnaire in multiple-choice format including seven questions was formulated (Figure 1). This was distributed to doctors at the XXV. Annual Meeting of Pediatric Surgery. One hundred and two out of 240 participants completed the questionnaires.

The survey consisted of seven questions and was divided into two sections: subject demographics, and information base. The three demographic questions included the institution, title, and experience of the participant. The information-base section was designed to assess the surgeons' understanding of potential risks of radiation exposure during diagnostic imaging and to compare this information with current radiology literature. Question 4 asked the participants to estimate the radiation dose received from different diagnostic imaging techniques compared to an equivalent number of chest radiographs. The next question (Q 5) asked whether surgeons believed that the lifetime risk of cancer for children is increased due to radiation exposure from one abdominal and pelvic CT scan. Question 6 asked whether the radiation dose received from one abdominal and pelvic CT scan might increase the lifetime risk for cancer and to what extent. The last question (Q6) asked to what extent the participants discussed with their patients' families the lifetime cancer risk increased by receiving radiation in routine practice.

X-rays are used in radiography, fluoroscopy, angiography, and CT imaging. The dose depends on patient factors (such as age and size), technical factors (equipment settings and procedure length), and equipment model. We choose a mid-range child (5 years old) with a radio sensitivity between that of infants and teenagers. Nevertheless, it is helpful to be familiar with some representative doses for common imaging studies (Table 1).[1]

We grouped the demographic data on experience (less than ten years as junior, or ten years and more as senior), title (participants with or without academic titles), and institution (participants who work in a training or non training hospital).

Chi-square test was used for statistical analysis.

RESULTS

Participants were from training hospital 69 (67.6%), state hospital, state hospitals 33 (32.4%) and private hospitals 9 (8.9%). Participant of survey were 66 (64.7%) nonacademic staff and academic staff 36 (35.3%). The experience of the participants showed a spectrum of, less than 10 years 44 (43.1%), and at least 10 years 58 (56.9%).

Pediatric surgeons gave a range of responses to question four (Table 2). Our estimated effective dose for CT abdomen and pelvis in a 5-year-old was 11.52 milisievert (mSv), equivalent to approximately 576 chest x-rays (CXRs) in a child of this

1 - Your institution

( ) Government hospital ( ) University/training hospital ( ) Private hospital

2 –Your Title

( ) Assistant ( ) Specialist ( ) Assistant Prof ( ) Assoc Prof ( ) Professor

3 -Years of clinical practice

( ) <5 ( ) 5–10 ( ) 11–20 ( ) >20

4- If we consider the effective dose of a frontal (PA) CXR on a 5 year old child to be one unit, how many equivalent units do you estimate the following investigations would be?

	0	1-10	20-49	50-99	100-250	>500	Do not know
CT abdomen + pelvis							
AP Pelvis X-ray							
Voiding cystourethrography							
Abdominal ultrasound							
Abdominal MRI							
CT chest							

5-Do you believe that the lifetime risk of cancer for children is increased from the radiation exposure of one abdominopelvic CT scan?

( ) Yes ( ) No

6-If you believe that the radiation dose from one abdominopelvic CT scan for child may increase may their lifetime risk fort he development of cancer, by what value do you think this risk of cancer is increased:

( )-No opinion ( )-1/1000 ( )-1/50000 ( ) 1/100000 ( ) 1/500000

7- In your opinion, at what level of excess lifetime cancer risk should we routinely discuss radiation risks with patients' families prior to a CT scan?

( )-1/1000000 ( )-1/10000 ( )- 1/1000 ( )-1/100 ( )-1/10 ( )-No important

FIGURE 1: Actual questions from the anonymous survey, which consisted of seven questions and was divided into two sections: subject demographics and information base.

age. The correct response (>500 chest x-rays) was given by 16.7% of surgeons, and 73.5% of the participants underestimated the radiation exposure for abdominopelvic CT examinations. The assessment that the relative effective dose of a pelvic radiograph is approximately ten times that of a frontal CXR was correctly defined by 73.5% of respondents, whereas 15.7% considered the dose to be an overestimate.

Some pediatric surgeons were not aware that magnetic resonance imaging (21.6%) and ultrasound (10.8%) were radiation free imaging techniques.

The answers to the question on the lifetime increased cancer risk due to radiation exposure from one abdominal and pelvic CT scan was yes in 49 (48%) participants and no in 53 (52%); 46.1% of respondents had no opinion to what extent the risk of cancer increased by exposure to radiation from one abdominal and pelvic CT scan (Table 3).

A considerable number of the participants (42.2%) did not consider discussing with their patients' families the increase in lifetime cancer by radiation exposure (Table 4).

TABLE 1: Estimated effective doses for a 5-year-old child (19 kg) at our institution.

	Effective dose (mSv)	CXR equivalents
PA Chest X-ray	0.02	1
AP pelvis X-ray	0.05	2.5
VCUG	0.4	20
CT abdomen + pelvis	11.52	576
CT chest	3.6	180
Abdomen MRI	0	0
Abdomen US	0	0

PA: Posterior-anterior, AP: Anterior-posterior, VCUG: Voiding cystourethrography, CT: Computerize tomography, US: Ultrasound, MRI: Magnetic rezonance imaging, mSv: milisievert, CXR: Chest X-ray

The difference between junior and senior pediatric surgeons, academic and nonacademic staff, and working in training or non-training hospital was not significant for questions 4-7 ($p > 0.05$).

DISCUSSION

Radiological examinations have an indispensable role in the diagnosis and treatment of disease, although radiation has been proven to have adverse biological effects on living organisms. These ad-

TABLE 2: Estimation of effective doses for a 5-year-old child in CXR equivalent units (Q 4).

PA Chest X-ray equivalents	0	1-10	20-49	50-99	100-250	>500	I do not know
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
CT Abdomen + pelvic	0 (0.0)	15 (14.7)	21 (20.6)	19 (18.6)	20 (19.6)	17 (16.7)	10 (9.8)
AP pelvis X-Ray	1 (1.0)	75 (73.5)	10 (9.8)	4 (3.9)	2 (2.0)	0 (0.0)	10 (9.8)
Voidingcystourethrography	0 (0.0)	27 (26.5)	29 (28.4)	26 (25.5)	5 (4.9)	7 (6.9)	8 (7.8)
Abdominal US	91 (89.2)	1 (1.0)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	9 (8.8)
Abdominal MRI	80 (78.4)	4 (3.9)	5 (4.9)	1 (1.0)	1 (1.0)	0 (0.0)	11 (10.8)
CT Chest	0 (0.0)	17 (16.7)	19 (18.6)	22 (21.6)	27 (26.5)	6 (5.9)	11 (10.8)

AP:Anterior-posterior, CT:Computerize tomography, US:Ultrasound , MRI:Magnetic rezonance imaging, CXR:Chest X-ray

TABLE 3: Estimates of increased risk of cancer from one abdominal/pelvic CT scan.

Estimated increased risk	No opinion	1/1000	1/50000	1/150000	1/250000
	n (%)	n (%)	n (%)	n (%)	n (%)
	47 (46.1)	16 (15.7)	14 (13.7)	5 (4.9)	20(19.6)

TABLE 4: Responses to questions 7 (routine discussion of radiation risks with patients' families prior to a CT scan).

Discuss radiation risks with patients' families	Not important	1/10	1/1.000	1/10.000	1/1000000
	n (%)	n (%)	n (%)	n (%)	n (%)
	43 (42.2)	12 (11.8)	21 (20.6)	18 (17.6)	8 (7.8)

verse effects vary according to the dose of radiation and duration of exposure.[9-11]

CT currently represents 10% of procedures and almost 70% of the overall radiation burden. Its use in children is increasing, probably even more rapidly than in adults, with an estimated 2.7 million pediatric CT examinations per year in the USA, and 30% of patients undergo at least three scans.[12]

Results of our study showed that 73.5% of pediatric surgeons underestimated the actual ionizing radiation dose patients were exposed during abdominopelvic CT. Rice et al demonstrated that 76% of pediatric surgeons underestimate the actual ionizing radiation dose received by the patient.[6] Underestimation of the actual dose of ionizing radiation might lead doctors to request radiological examinations more often than is necessary and safe. This means increased risk for patients.[13] The advent of hospital wide electronic requesting systems may be an opportunity to educate clinicians more effectively than can be achieved by formal continuing professional education; systems may provide dose statistics for each investigation requested. Thus, information on radiation protection could be imparted at a time when it would be most pertinent to the patient and most likely to be retained by the clinician, at the time of requesting investigation.[14]

An informal survey in the as low as reasonably achievable (ALARA) Conference estimated that up to 30% of pediatric CT requests were unlikely to benefit the individual or could be easily and effectively replaced by a non-ionizing imaging modality.[15] Therefore, in radiological practice, in keeping with ALARA principle, minimum exposure of the patient and radiology staff is mandatory. Radiological examinations that are unnecessary and not supportive of diagnosis create risks for patients.

The majority of the respondents (46.1%) were not aware of the extent of increased risk of cancer by exposure to radiation from one abdominal and pelvic CT scan and only 15.7% knew that there was 1 fatal cancer for every 1000 CT scans performed in a young child. Several reports by Brenner et al concluded that there might be up to 500 extra cases of fatal cancer from the CT scans performed on children annually in the United States based on es-

timates of the number of CT examinations performed.[16,17] A single abdominal CT protocol lead to approximately 1 fatal cancer for every 1000 CT scans performed in a young child.[6]

We saw that pediatric surgeons were not aware that magnetic resonance imaging (21.6%) and ultrasound (10.8%) were radiation free imaging techniques. Arslanoğlu et al in their study including doctors and intern doctors, reported that 4% claimed US and 27% claimed MRI used ionizing radiation.[14]

CONCLUSION

The results of this study suggest that the knowledge level of Turkish pediatric surgeons is inadequate on radiation exposure of patients during diagnostic imaging. Graduate and postgraduate education programs of pediatric surgeons should include information on ionizing radiation doses of diagnostic imaging techniques. In addition, patients and their families should be informed on the lifetime cancer risks of ionizing radiation.

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