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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Pediatrik Hastalarda COVID-19 Pandemisinde Toraks BT Kullanımına Bağlı Radyasyon Maruziyetinin Belirlenmesi

Determination of Radiation Exposure Related to the Use of Chest CT During COVID-19 Pandemic in Pediatric Patients

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Abstract

Aim: The main goal of this study was to determine the radiation exposure with use of chest computed tomography (CT) in pediatric patients in Coronavirus disease 2019 (COVID-19) pandemic.

Material and Method: Children who underwent thorax CT with a pre-diagnosis of any pneumonia between April-September in 2019 and April-September in 2020 were included. Kilovoltage peak (kVp) was decreased about 10% to reduce radiation exposure per scan in 2020. Dose-length product (DLP) was acquired from patient protocol screen in CT scans. Age-specific conversion coefficients were used to determine effective dose. Monthly amount of chest CT was compared between 2019 and 2020. Total radiation exposure was calculated by summing effective doses in 2019 and 2020, respectively. Age and gender differences were compared among years (2019 vs 2020) using Student's T test and Fisher's Exact test, respectively.

Results: Three-hundred-sixty-six children were included. Seventy and 296 patients were scanned with chest CT in 2019 and 2020, respectively. Three patients were re-scanned with CT in 2020. There was a substantial increase of CT use in August and September in 2020 compared with the same period of 2019 (114 vs 8). Monthly use of CT in 2020 was significantly higher than those in 2019 (p=0.024). The total effective doses in 2019 and 2020 were 223.21 mSv and 590.92 mSv, respectively. Radiation dose increased by 2.65 times with increased use in 2020. Age of the patients was significantly higher in 2020 (p<0.001) while there was no gender difference by years (p=0.11).

Conclusion: Radiation dose increased 2.65 times in children with use of chest CT during the COVID-19 pandemic. Awareness should be raised on radiation exposure and use of unnecessary chest CT should be avoided and CT indications should be revised in children.

Keywords: Computed tomography, COVID-19, pandemic, pediatric, radiation exposure

Öz

Amaç: Bu çalışmanın temel hedefi, çocuk hastalarda, Coronavirus hastalığı 2019 (COVID-19) pandemisinde toraks bilgisayarlı tomografisi (BT) kullanımının neden olduğu radyasyon maruziyetinin belirlenmesidir.

Gereç ve Yöntem: Nisan-Ekim 2019 ve Nisan-Ekim 2020 tarih aralığında pnömoni ön tanısıyla toraks BT çekilen çocuk hastalar çalışmaya dahil edildi. Kilovolt (kVp) %10 civarında düşürülerek çekim başına radyasyon maruziyeti 2020'de azaltıldı. Doz-uzunluk çarpımı (DLP) BT taramasındaki hasta protokol ekranından elde edildi. Efektif doz hesaplamada yaşa göre değişen çevrim faktörü kullanıldı. Toplam radyasyon maruziyeti, 2019 ve 2020 yılları için ayrı ayrı, efektif dozlar toplanarak hesaplandı. Yıla (2019 ve 2020) göre, yaş ve cinsiyet farklılığı, sırasıyla T testi ve Fisher Exact Testi kullanılarak karşılaştırıldı.

Bulgular: Çalışmaya 366 çocuk dahil edildi. Bilgisayarlı tomografi çekilen olgu sayısı 2019 ve 2020 yıllarında sırasıyla 70 ve 296 idi. Üç hasta, 2020'de BT ile tekrar tarandı. Ağustos ve Eylül 2020'de aynı zaman diliminde 2019'a göre BT kullanımında belirgin artış vardı (114'e karşın 8). Aylık toraks BT kullanımı 2020 yılında, 2019'dan anlamlı derecede daha fazlaydı (p=0.024). Toplam efektif dozlar 2019 ve 2020 için sırasıyla 223.21 mSv ve 590.92 mSv idi. Artan BT kullanımı ile birlikte radyasyon dozu 2020'de 2.65 kat arttı. Bilgisayarlı tomografi yapılan olguların yaşı 2020'de belirgin daha yüksek iken (p<0.001), cinsiyet açısından fark yoktu (p=0.11).

Sonuç: COVID-19 pandemi sürecinde toraks BT kullanımı nedeniyle çocuklarda radyasyon maruziyeti 2.65 kat arttı. Radyasyon maruziyeti konusunda farkındalık artırılmalı ve çocuklarda gereksiz toraks BT kullanımından kaçınılmalı, BT endikasyonları gözden geçirilmelidir.

Anahtar Kelimeler: Bilgisayarlı tomografi, COVID-19, pandemi, pediatri, radyasyon maruziyeti

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INTRODUCTION

A mysterious virus emerged and caused pneumonia in Wuhan in December 2019 (1). The causative agent was isolated and named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (2). After a short time, it affected whole world and caused the pandemic which was described as Coronavirus disease 2019 (COVID-19) pandemic by World Health Organization (3). The epidemiological studies showed that 1.7%-2.2% of children were affected (4,5).

The diagnosis of COVID-19 disease is based on nucleic acid tests, real time-polymerase chain reaction (RT-PCR). Nasopharynx or throat mucosa are sampled with a swab for RT-PCR test (6). Chest X-ray or computed tomography (CT) are imaging modalities commonly used (7). Imaging may be normal in pediatric patients since about 80% of children had mild disease (8). Chest X-ray should be first line imaging method considering radiation exposure, especially in children (9). On the other hand, CT has the highest diagnostic accuracy even comparable with PCR-test despite causing high dose radiation (10).

In this study, it was aimed to determine the radiation exposure related to the use of chest CT in pediatric patients during COVID-19 pandemic.

MATERIAL AND METHOD

Study Design

The principles of the Declaration of Helsinki were conformed in this retrospective study. Permission was obtained from Ministry of Health. This study was conducted in the third level referral and pandemic children's hospital. Children who underwent thorax CT with a pre-diagnosis of infection between April-September in 2019 and April-September in 2020 were included in this study. International Classification of Disease code, anamnesis note, and CT scan notes of the physicians were used to determine the indication for CT examinations. The patients who had a pre-diagnosis of non-infectious disease were excluded. Non-thorax CT examinations were also excluded.

Chest CT examination was performed using a 32 multi-slice machine (SOMATOM go.Now, Siemens, Erlangen, Germany) with a standard protocol (kVp: 120; mAs: 14-350 with automated exposure; pitch: 1.0; acquisition slice thickness: 1mm) in 2019 without contrast medium. In 2020, dose was slightly reduced by decreasing kilovoltage peak (kVp) , the peak potential applied to the CT tube, from 120 to 110 while other parameters remained the same. Tube radiation as dose-length product (DLP), a measure of CT tube total radiation output, was recorded in all CT examinations on patient protocol screen (**Figure 1**). Monthly use of CT in 2020 was significantly higher than those in 2019. Effective doses were calculated using the formula of Effective dose (mSv)=DLP x conversion factor. Age-specific conversion coefficients were used as proposed by Thomas et al. (11). Total radiation exposure was calculated by summing effective doses in 2019 and 2020, respectively.

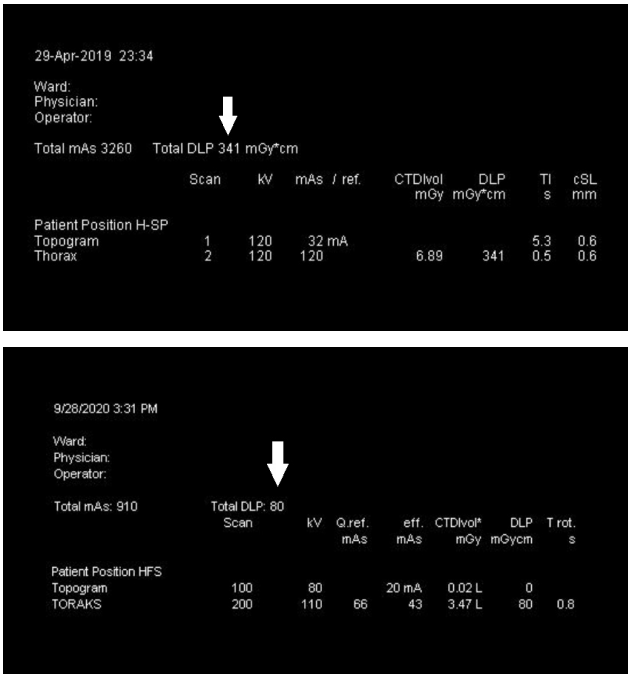

Figure 1. Two different patients' CT protocols in 2019 and 2020, respectively. Arrows are showing dose-lenght product values.

Statistical Analysis

Statistical tests were performed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp, Armonk, NY, USA). The numbers of CT scans were calculated by months in 2019 and 2020. Age and gender differences were compared among years (2019 vs 2020) using Student's T test and Fisher's Exact test, respectively. P-value of <0.05 was considered statistically significant.

RESULTS

The total number of patients included in this study was 366. The median age was 13 years (5.2). There were 186 boys and 180 girls. The numbers of patients who had chest CT scans with a pre-diagnosis of infection were 70 in 2019 and 296 in 2020, respectively. There was no repetition of CT scans in 2019 while 3 cases had twice chest CT in 2020. Accordingly, the total number of chest CT scans was 299 in 2020 .

The numbers of chest CT scans from April to September were 25, 20, 7, 10, 6 and 2 per months, respectively , in 2019. They were 72, 45, 37, 31, 74 and 40 per months in 2020, respectively (**Figure 2**). There was a substantial increase of CT use in August and September in 2020 compared with the same period of 2019 (114 vs 8). Monthly use of CT in 2020 was significantly higher than those in 2019 (p=0.024). The mean DLP was 158 (range, 54-305) mGy×cm in 2019, while the mean DLP was 145 (range, 14-446) mGy×cm in 2020. The mean effective doses were 3.18 (0.66) mSv and 1.98 (1.16) mSv in 2019 and 2020, respectively . The total effective doses in 2019 and 2020 were 223.21 mSv and 590.92 mSv, respectively . Radiation dose increased by 2.65 times with prevalent use of chest CT in 2020.

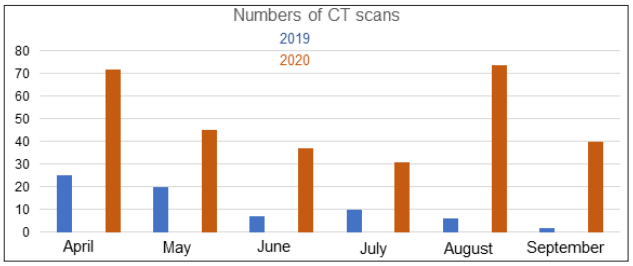

Figure 2. The numbers of the patients had thorax CT scans by months in 2019 and 2020. Note that there is substantial fold in August and September in 2020.

Age of the patients who had chest CT in 2020 was significantly higher than those who had chest CT in 2019 (p<0.001) (**Table 1**). However, there was no gender difference between two groups (p=0.11) (**Table 2**).

Table 1. Patients' age difference between 2019 and 2020

	Age		P value
	Mean	SD	
CT Scanned in 2019 (n:70)	5.70	5.04	< 0.001
CT Scanned in 2020 (n:296)	12.49	4.33	

CT, computed tomography; SD, standard deviation.

Table 2. The comparison of the numbers of CT scans among genders in 2019 and 2020

Gender	The Numbers of thorax CT scans		P value
	2019	2020	
Boys	42	144	0.11
Girls	28	152	
Total	70	296	

CT, computed tomography.

DISCUSSION

In this study, a 2.65-fold increase in radiation exposure was determined in the pediatric patients related to the use of thorax CT during the 6 months in COVID-19 pandemic compared to same period in 2019 despite slightly reducing the dose per scans in pandemic. Additionally, age of patients who underwent thorax CT during this period in 2020 was significantly higher than those scanned in 2019.

Chest X-ray is first line imaging modality in children with COVID-19 pneumonia (9). Fleischner Society supports use of CT for follow-up and complications in COVID-19 pneumonia (12). On the other hand, sensitivity of thorax CT in the diagnosis of COVID-19 pneumonia was found to be significantly higher than the sensitivity of chest X-ray (85% vs 56%, respectively) (13). Ai et al reported that 88% of suspected cases had findings suggestive of COVID-19 in chest CT while the positive rate of RT-PCR test was only 59% (14). These findings may be used to justify the use of CT in screening and diagnosis of COVID-19. In this study, use of chest CT increased 4.3 times in 2020 compared to 2019 with a pre-diagnosis of infectious diseases.

COVID-19 usually has a mild clinical course in children (8). Mortality rate is about 1% in children (15). Duan et al claimed that the disease caused milder lung abnormalities in children and chest CT should be used with more caution in younger population (16). In the meta-analysis of Shelmerdine et al 34% of children with COVID-19 had normal CT (17). In this study, a 2.65-fold increase in radiation exposure was determined with increased use of chest CT. Use of CT, hence radiation exposure, should be limited in children since the disease has an asymptomatic or mild course with an extremely low mortality rate in children. Benefits from the use of CT should be carefully weighed against the long-term side effects of radiation exposure in this age group.

Fleischner Society does not provide guidance on frequency of its use, and specific scan protocols to reduce radiation dose (12). CT usage in patients with COVID-19 pneumonia showed wide variations across the world. CT acquisition with either low or standard dose is controversial, as well. International Atomic Energy Agency (IAEA) coordinated a multicenter study about CT use in 28 countries in COVID-19 and found that only 20% of the centers used reduced-dose (lower than routine protocol) (18). Some authors had reliable results using low-dose CT (19, 20). However, Shiri et al found a significant decrease in image quality with reduced dose (21). In this study, radiation dose was slightly reduced by nearly 10% decreasing in kVp in 2020. Thus, the number of CT scans increased 4.3 times, while the radiation exposure raised only 2.65 times in pandemic.

This study has some limitations. First, this is a retrospective study evaluating data retrieved from medical records and previous CT scans. Second, it does not reflect the exact increase in radiation exposure in COVID-19 pandemic since only thorax CT scans were included and exposure from chest X-ray were not considered. Third, it was conducted in one center and local practice on CT use may have affected the results. Fourth, PCR results of the cases exposed to radiation were unknown; only radiation perspective was introduced.

CONCLUSION

Radiation dose increased 2.65 times in children related to the use of thorax CT during the COVID-19 pandemic. Awareness should be raised about radiation exposure in children and unnecessary use of CT should be avoided , and CT indications should be revised in children.

ETHICAL DECLARATIONS

Ethics Committee Approval: The principles of the Declaration of Helsinki were conformed in this retrospective study. Permission was obtained from Ministry of Health.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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