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The Analysis of Thoracic Computed Tomography before and after COVID-19 Pandemic

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ABSTRACT

Aim: The aim of this study is to describe the changes in the number of Thoracic Computed Tomographs (TCT) taken from the emergency department (ED) and the general characteristics of the patients concerned.

Material and Methods: The patients were examined in two periods as before and after March 10 (Period 1: January 1, 2020 - March 9, 2020; Period 2: March 10-31, 2020), the date COVID-19 first occurred in our country. Furthermore, if COVID-19 findings were present, the severity of the findings, the side involved (right lung, left lung, bilateral), the number of lobes involved, the type of the finding observed, the localization of the lesions were identified.

Results: The daily number of TCT scans increased by approximately two-folds after March 10. A total of 400 TCT scans were performed in Period 1. In a total of 69 days, the average daily TCT number was 5.8, and the number of cases consistent with viral pneumonia was 21 (5.25% of the TCT scans on these dates). A total of 243 TCT scans were performed in Period 2. In a total of 22 days, the daily number of TCT scans was 11.04, and the number of patients consistent with viral pneumonia (COVID-19 included) was 44 (18.1% of the TCT scans on these dates).

Conclusion: During this period, while it is still being debated whether COVID-19 is a biological attack or not, the significant increase in exposure to ionizing radiation with known risks is a matter worthy of discussion.

Keywords: Emergency Department; thoracic computed tomography; COVID-19; ionizing radiation.

COVID-19 Pandemisinden Önce ve Sonra Çekilen Toraks Bilgisayarlı Tomografilerin Analizi

ÖZ

Amaç: Bu çalışmanın amacı, acil servisten çekilen toraks bilgisayarlı tomografilerin (TBT) sayısındaki değişiklikleri ve ilgili hastaların genel özelliklerini tanımlamaktır.

Gereç ve Yöntemler: Hastalar ülkemizde COVID-19'un ilk ortaya çıktığı tarih olan10 Mart öncesi ve sonrası olmak üzere iki dönemde incelenmiştir (Dönem 1: 1 Ocak 2020 - 9 Mart 2020; Dönem 2: 10-31 Mart 2020). Ayrıca COVID-19 bulguları mevcutsa, bulguların şiddeti, ilgili taraf (sağ akciğer, sol akciğer, bilateral), etkilenen olan lob sayısı, gözlenen bulgunun tipi, lezyonların lokalizasyonu belirlenmiştir.

Bulgular: Günlük TBT taraması sayısı 10 Mart'tan sonra yaklaşık iki kat artmıştır. Dönem 1'de toplam 400 TBT taraması yapıldı. Toplam 69 günde, ortalama günlük TBT sayısı 5,8 ve viral pnömoni ile uyumlu vaka sayısı 21 idi (bu tarihlerde çekilen TBT taramalarının %5,25'i). Dönem 2'de toplam 243 TBT taraması gerçekleştirildi. Toplam 22 günde, günlük TCT taraması sayısı 11,04 idi ve viral pnömoniyle uyumulu hasta sayısı (COVID-19 dahil) 44 (bu tarihlerde çekilen TBT taramalarının %18,1'i).

Sonuç: COVID-19'un biyolojik bir saldırı olup olmadığı hala tartışılırken, iyonizan radyasyona maruziyetinde ki bu artışın tartışmaya değer bir konu olduğunu düşünüyoruz.

Anahtar Kelimeler: Acil Servis; torasik bilgisayarlı tomografi; COVID-19; ionizan radyasyon.

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INTRODUCTION

The emergency department, one of the two doors where the patients enter the hospital, are getting more crowded every year. In many hospitals, the emergency department visits are higher than visits made to other polyclinics (1). This increased patient density leads to increased testing. It has been reported that computed tomography scans have increased 20-fold in recent years (2). Thoracic computed tomography (TCT) is one of the scans used frequently at the emergency departments, particularly to evaluate life-threatening pathologies (pneumothorax, hemothorax, pneumonia, pneumomediastinum, aortic dissection, pulmonary thromboembolism, etc.). TCT has an essential role in the early diagnosis and determination of the disease severity of the COVID-19 pandemic, which began in China at the end of 2019 and subsequently affected the whole world (3). Since March 10, 2020, when the disease was first seen in our country, a substantial increase in the number of TCT scans performed in the emergency departments has been observed. The purpose of this study was to identify the changes in the number of TCT scans ordered by the emergency department and the average age of the relevant patients, and to identify the characteristic features of probable COVID-19 cases.

MATERIAL AND METHODS

This study was launched under the approval of the Duzce University Non-Invasive Health Research Ethics Committee. An average of 250 patients visits our emergency department daily (the number of daily visits after March 10 is 100-130). The authors declared that the study carried out in accordance with the rules of scientific research and publication ethics. The first COVID-19 case in our country was announced by our Minister of Health on March 10, 2020. From that date onwards, in our hospital, the differential diagnosis was carried out by obtaining TCT scans and PCR samples from patients considered as probable cases. Especially after March 12, findings consistent with COVID-19 began to be detected in TCT scans from the emergency department. Besides, the number of daily TCT scans increased by two-folds as of March 10. In this study, the TCT scans from the emergency department of January, February, and March were evaluated retrospectively.

Procedure

All TCT scans from the emergency department between January 1, 2020 and March 31, 2020 were identified through the hospital's PACS system. All of the identified TCT scans were evaluated by one radiologist and one emergency medicine specialist on a Totoku brand medical monitor (one with 20 years and the other with 4 years of experience).

The daily TCT numbers, the average age of the patients, the presentation date, gender proportions, findings of viral pneumonia, additional pathologies (categorized under the headings of emphysema/chronic bronchitis, atelectasis, fibrotic changes, pleural effusion, pulmonary edema, mass, nodule, chronic bronchiectasis, and others) and the TCT scans that appear normal were identified.

The patients were examined in two periods as before and after March 10 (Period 1: January 1, 2020 - March 9, 2020; Period 2: March 10-31, 2020), the date COVID-19 first occurred in our country. Furthermore, if COVID-19 findings were present, the severity of the findings, the side involved (right lung, left lung, bilateral), the number of lobes involved, the type of the finding observed (ground glass, crazy paving, reverse halo, consolidation, distortion, bronchiectasis), the localization of the lesions (peripheral, central) were identified. The data obtained were analyzed.

Statistical Analysis

The conformity of the numerical data for the normal distribution was tested with the Shapiro-Wilk test. The Student's t-test was used for the numerical variables showing normal distribution among the two independent groups, and the Mann-Whitney U test was used for the non-normally distributed numerical variables. A chi-square test was used to compare two independent groups in terms of categorical data. Number and percentage were given for the categorical variables as descriptive statistics. The SPSS Windows version 24.0 software bundle was used for the statistical analyses, and a P value of <0.05 was considered statistically significant.

RESULTS

Between January 1, 2020, and March 31, 2020, a total of 643 patients had undergone TCT scans (including trauma cases). The average age of the patients was 60.68 ± 21.70 (2 - 107) and 52.26% were male (n= 336). Findings of viral pneumonia were present radiologically in a total of 65 patients. Of these cases, 21 (32.3%) were observed during Period 1. TCT findings radiologically consistent with COVID-19 appeared in a total of 36 patients after March 12. The first PCR-positive case was identified on March 19. The daily number of TCT scans increased by approximately two-folds after March 10 (Figure-1).

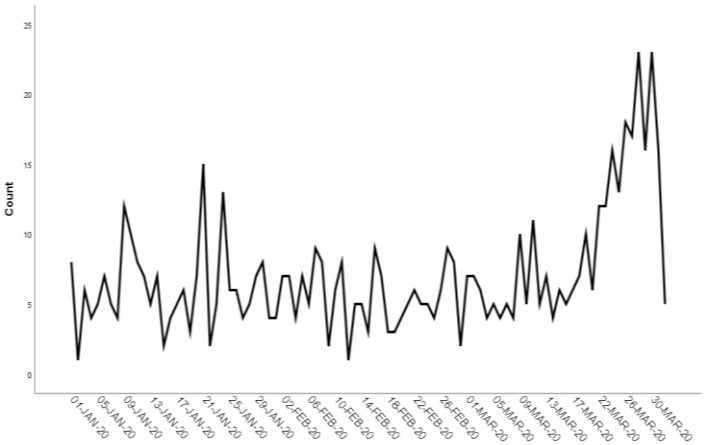

Figure 1. The change of Thoracic Computed Tomography scan numbers by date

A total of 400 TCT scans were performed in Period 1. In a total of 69 days, the average daily TCT number was 5.8, and the number of cases consistent with viral pneumonia was 21 (5.25% of the TCT scans on these dates). A total of 243 TCT scans were performed in Period 2. In a total of 22 days, the daily number of TCT scans was 11.04,

Table 1. Descriptive and comparative data

	Total TCT n= 643	**January 1, 2020 - March 9, 2020 n= 400**	**10-31 March 2020 n= 243**	**p-value**
Daily average TCT	7.06	5.80	11.04	-
Age (Mean ± SD) (min-max) Median [Q1 Q3]	60.68 ± 21.70 (2-107) 68 [48 77]	64.51 ± 20.92 (2-82) 71 [65 77]	54.36 ± 21.51 (2-107) 60 [44 76]	<0.001*
Gender (Male)	336 (52.26%)	201 (50.25%)	135 (55.55%)	0.192
Findings of Viral Pneumonia	65 (10.11%)	21 (5.25%)	44 (18.11%) • COVID-19 36 (14.81%)	<0.001
Additional pathology ** -Emphysema / Chronic bronchitis -Pneumonia -Atelectasis -Fibrotic changes -Pleural effusion -Pulmonary edema -Mass -Nodule -Chronic bronchiectasis -Other	378 (58.79%) 36 (9.36%) 94 (24.40%) 38 (9.88%) 33 (8.58%) 104 (27.04%) 86 (22.36%) 12 (3.12%) 14 (3.64%) 10 (2.60%) 27 (7.02%)	266 (66.50%) 19 (7.22%) 78 (29.64%) 30 (11.40%) 23 (8.74%) 76 (28.88%) 55 (20.90%) 11 (4.18%) 6 (2.28%) 6 (2.28%) 17 (6.46%)	112 (46.10%) 17 (15.13%) 16 (14.24%) 8 (7.12%) 10 (8.90%) 28 (24.92%) 31 (27.59%) 1 (0.89%) 8 (7.12%) 4 (3.56%) 10 (8.9%)	<0.001
Normal TCT	217 (33.75%)	119 (29.75%)	98 (40.32%) Male 56 (57.10%)	0.006

* The P-value was obtained from the Mann Whitney U test. The other p values were obtained from the Chi-square test
** More than one additional pathology may be observed in one patient.
TCT: Thoracic computed tomography; SD: Standard deviation, min: Minimum; max: Maximum, Q: Quartiles

and the number of patients consistent with viral pneumonia (COVID-19 included) was 44 (18.1% of the TCT scans on these dates). The review of the average ages of the patients through the two periods showed that the average age was 64.51±20.92 (2-82) [median (quartile(q)1 q3): 71 (65 77)] during period 1 and 54.36±21.51 (2-107) [median (q1 q3): 60 (44 76)] during period 2 (p<0.001). No pathology was observed on 217 of the TCT scans performed; 119 of these scans were from Period 1 and comprised 29.75% of the TCT scans performed in this period, and no pathology was observed in 40.32% of the TCT scans performed in Period 2 (p=0.006). No difference in gender proportions was determined between the two periods (p>0.05), but additional pathologies were observed to a lower extent in Period 2 (p<0.001) (Table-1).

The average age of the 36 cases consistent with COVID-19 was calculated as 56.61±19.26. 38.9% were male, 66.6% of the lesions were bilateral, and 47.3% of the cases had involvement in all 5 lobes. The most common radiological finding was ground glass opacity (92.4%), and the lesions were localized peripherally in 81.2% of the patients (Table-2). The TCT images of some cases have been presented in Figure-2.

Table 2. The general characteristics of COVID-19 consistent cases

Age [mean± SD (min-max)]	56.61±19.26 (21-92)
	n (%)
Total Cases	36 (100%)
Gender (Male)	14 (38.90%)
Side affected	Bilateral 24 (66.60%) Unilateral 12 (33.40%)
Number of lobes affected	1 lobe 7 (19.40%) 2 lobes 3 (8.30%) 3 lobes 5 (13.90%) 4 lobes 4 (11.10%) 5 lobes 17 (47.30%)
COVID-19 Specific findings (% of the patients)	
• *Ground glass*	33 (92.40%)
• *Crazy paving*	24 (75.60%)
• *Bronchiectasis*	19 (53.20%)
• *Distortion*	15 (42%)
• *Consolidation*	14 (39.20%)
• *Reverse halo*	5 (14%)
Lesion Localization (% of the patients) • *Central* • *Peripheral*	 17 (50.40%) 29 (81.20%)
Additional Pathologies	7 (19.60%)

SD: Standard deviation, min: Minimum; max: Maximum

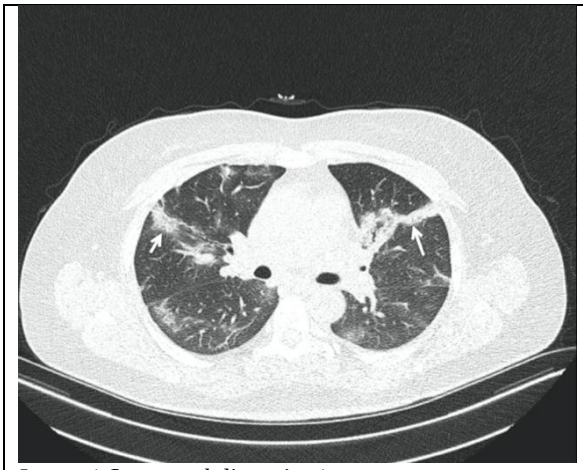

Image 1 Structural distortion1

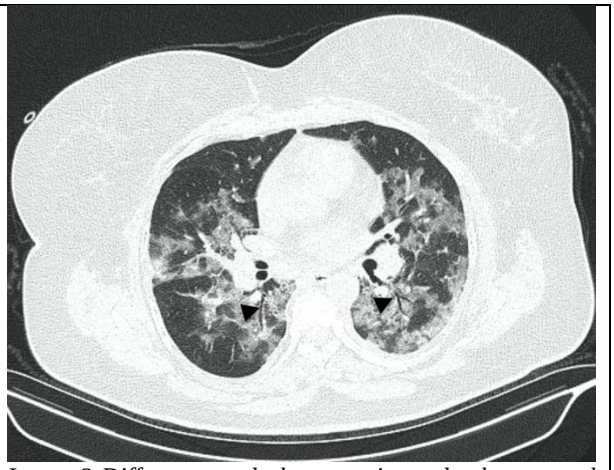

Image 2 Diffuse ground glass opacity and subsegmental bronchiectasis2

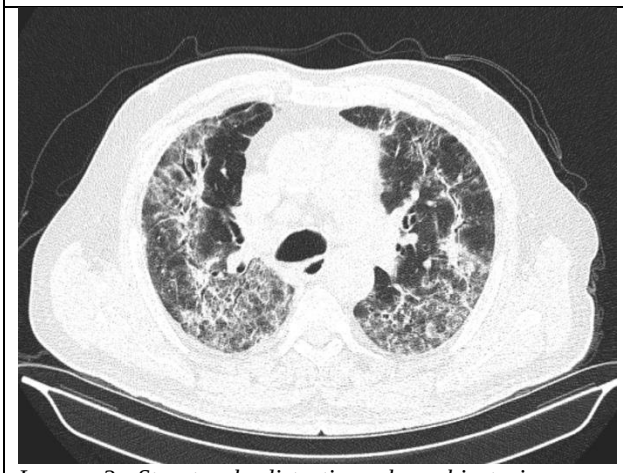

Image 3 Structural distortion, bronchiectasis, crazy paving3

Image 4 Subpleural grounded glass opacities and bronchiectasis4

Figure 2. Thoracic computed tomography images of some cases

DISCUSSION

The increasing use of tomography in recent years continues to inspire many studies. Although it causes exposure to ionizing radiation, it will continue to be preferred, because it is a cheap and fast method and is the gold standard for the diagnosis of many diseases. In our study, no pathology was observed in 29.75% of the TCT scans performed in Period 1, and 40.32% of the TCT scans performed in Period 2. In the study by Güleç et al. (4) in which they reviewed the TCT images of 215 patients, they determined that no pathology was present in 14% of the TCT scans. Perelas et al. (5) determined that 19.9% of the tomography scans performed were completely normal in their study in which they reviewed 580 patients who had undergone thoracic CT angiography. In the study in which they evaluated 81 patients with COVID-19 related history of contact and specific symptoms who visited the hospital over one month (December 20, 2019 – January 23, 2020), Shi et al. (6) observed significant pathological findings in all of the patients. Yoon et al. (7) did not observe pathological findings in the lung parenchyma of 33.3% of the cases in the study in which they reviewed the TCT findings of COVID-19 suspected patients. Similarly, in Italy, Caruso et al. (8) did not observe any pathology in 36% of the TCT scans in the study they conducted with 158 suspected COVID-19 patients (the PCR result was also negative in 96.4% of the patients with no TCT findings). In the study conducted in Wuhan by Ai et al. (9) with 1014 patients, no findings were observed on the TCT scans of 12.43% of the patients (the PCR result was also negative in 83.33% of the patients with no TCT findings). In particular, the number of studies comparing the diagnostic values of RT-PCR and TCT is gradually increasing (8,9). We believe that TCT is being preferred more and more due to its role in the early detection of the disease and the long test duration of RT-PCR. In our study in particular, we see that TCT numbers doubled once the COVID-19 cases started to appear. We do not have the data of the TCT scans performed in the hospitals where the studies mentioned above were performed before the pandemic. However, we believe that the number of TCT scans is increasing rapidly. Although it is known that TCT has an essential role in identifying the disease severity (10), in line with the data that TCT follow-ups are also performed in 1/8 of the patients (11), we think that a less frequent use of TCT in the diagnosis

of patients with mild to moderate clinical presentation will reduce exposure to ionizing radiation.

In different studies, the average age of patients who had undergone TCT scans were calculated as 58±14.97; 60.33; 49.5±11; 57±17 (4-6,8). In our study, while the average age was 64.51±20.92, it decreased to 54.36±21.51 after March 10 ($p<0.001$). When we reviewed the genders, it was observed that less than half of the patients who had undergone TCT scans were female in previous studies (34%; 48%; 47.5%) (4,6,8). Similarly, in our study, it was observed that males had undergone more TCT scans before and after March 10. Again, it was observed that the male gender was dominant in TCT scans that appeared normal. There are data available that radiation exposure is associated with lung cancer, and that low dose TCT reduces the cancer-related mortality and morbidity (12). It is known that the dense breast tissue in females, particularly during the reproductive age, is more sensitive to radiation (13,14). The importance of TCT in the early diagnosis of patients is not to be taken lightly, and it is known that lung radiography with less ionizing radiation has a lower sensitivity (69% sensitivity) (15). Early diagnosis of the disease is of significant importance in the early isolation of probable cases, but all patients diagnosed with COVID-19 by TCT are confirmed by PCR. It should also be noted that there are also TCT-negative but PCR-positive cases. Especially in the first 2 days of the symptoms, TCT may appear normal in approximately half of the cases (16). We think that this increase in the number of TCT scans during the pandemic is not very abnormal, but the degree of use close to being used as a screening test should be considered abnormal.

In our study, COVID-19 findings were observed in 36 patients. The most common finding was ground glass opacity (92.4%), involvement was mostly bilateral (66.6%), most of the lesions (81.2%) were localized peripherally, and in most cases, all 5 lobes were involved (47.3%). Ai et al. (9) observed consolidation the most (50%), and the lesions were bilateral (90%). In the cases they included in their study, Yoon et al. (7) mostly observed consolidation, and the lesions were mainly localized peripherally whereas, Caruso et al. (8) observed ground glass opacity the most (100%), that >2 lobes were involved in 93% of the cases, that the ground glass densities were mostly peripheral (89%) and that 91% of the lesions were bilateral. In the study by Brenheim et al. (17), which they conducted with 121 cases, the lesions mostly involved all 5 lobes (27%) and were mostly bilateral (60%), the most frequent lesions were ground glass opacity and consolidation. In the systematic analysis including 919 patients conducted by Salehi et al. (18), the most common lesion was ground glass opacity (88%), the lesions were mostly bilateral (88%) and mainly localized posteriorly and peripherally (80% & 76%), and 79% of the cases had multi-lobar involvement. It was observed that the COVID-19 findings on the TCT images were also similar in our study.

LIMITATIONS

- In the relevant hospital, the initial diagnostic approach to cases uses TCT; it is not possible to confirm all COVID-19 cases with consistent TCT appearances confirmed by PCR. Therefore, the study was designed based on TCT findings.
- Due to the fact that the TCT numbers before COVID-19 were not included in many studies, the debate could not evolve further in that direction.

CONCLUSION

After the first case of COVID-19 appeared in our country, the number of patients undergoing TCT scans increased substantially, and the average age decreased. Accordingly, the number of TCT scans that appeared completely normal increased. Although the sensitivity of TCT is high, all patients are confirmed by PCR, and the treatment and discharge processes are also based on the PCR results. During this period, while it is still being debated whether COVID-19 is a biological attack or not, the significant increase in exposure to ionizing radiation with known risks is a matter worthy of discussion.

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