Evaluation of thoracic computed tomography interpretation by emergency medicine residents with regards to accuracy and confidence

Acil tıp araştırma görevlilerinin, toraks bilgisayarlı tomografisi yorumlamada doğruluk ve özgüven açısından değerlendirilmesi

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Abstract

Purpose: Interpretation of thoracic computed tomography (CT) scans by emergency department (ED) physicians is important especially in crowded EDs. The aim of this study is to assess the proficiency and confidence of ED physicians with varying levels of experience in interpreting thoracic CT.

Materials and methods: A total of 25 pathological and 5 normal thoracic CT images were interpreted by 32 ED residents, initially without clinical information, then with. After each session the participants were asked to score their confidence on a scale of 1 to 10. At the end of the study, the results were compared between seniors and junior residents.

Results: The median age of the participants was 29 years (24-34). Twenty (62.5%) of the residents were junior residents. There were no significant differences between the two resident groups in terms of accurate diagnosis rates, regardless of the clinical information (p=0.307 and p=0.061). The physicians' certainty of their own diagnosis mostly does not seem to be statistically different in these diagnoses. The seniors are more confident in the diagnosis of the CT scans they evaluated without clinical information (p=0.004), while when the clinical information is added, the confidence of the junior physicians also increase (p=0.087).

Conclusion: Both senior and junior emergency medical residents are able to interpret thoracic CT images with a high degree of accuracy, both for COVID-19 and for other emergency diagnoses. Senior physicians were confident in their decisions regardless of whether they are accurate or not, solely by visual inspection, whereas junior residents displayed similar confidence when clinical information was available.

Keywords: Clinical information, confidence, emergency medicine, residents, thoracic computed tomography.

Öz

Amaç: Özellikle kalabalık acil servislerde, toraks bilgisayarlı tomografisinin (BT) acil hekimleri tarafından yorumlanması önemlidir. Çalışmanın amacı, toraks BT'sinin yorumlanmasında farklı düzeylerde deneyime sahip acil tıp araştırma görevlisi hekimlerinin yeterliliklerini ve özgüvenlerini değerlendirmektir.

Gereç ve yöntem: Yirmibeş patolojik ve 5 normal toraks BT görüntüsü, başlangıçta klinik bilgi olmadan, daha sonra da klinik bilgi eklenerek 32 acil tıp araştırma görevlisi hekim tarafından yorumlanmıştır. Her oturumdan sonra katılımcılardan kararlarına olan güvenlerini 1 ila 10 arasında bir ölçekte puanlamaları istenmiştir. Çalışmanın sonunda, elde edilen sonuçlar kıdemli (2 yıl ve üzeri acil tıp tecrübesi olan) ve daha az tecrübesi olan araştırma görevlisi hekimlerin arasında karşılaştırılmıştır.

Bulgular: Katılımcıların ortanca yaşı 29 (24-34) idi. Araştırma görevlisi hekimlerin 20'si (%62,5) daha az tecrübesi olan gruptaydı. İki araştırma görevlisi hekim grubu arasında, klinik bilgiden bağımsız olarak, doğru tanı koyma oranları açısından anlamlı fark saptanmamıştır (p=0,307 ve p=0,061). Kıdemliler klinik bilgi olmadan toraks BT'lerini değerlendirirken, kendilerine, daha az tecrübesi olan araştırma görevlisi hekimlere göre, daha fazla güvenmektedirler (p=0,004). Klinik bilgi eklendiğinde daha az tecrübesi olan araştırma görevlisi hekimler de kıdemli hekimler kadar kendi tanılarına güvenmektedirler (p=0,087).

Sonuç: Hem kıdemli hem de daha az tecrübesi olan acil tıp araştırma görevlisi hekimler, toraks BT görüntülerini hem COVID-19 hem de diğer acil teşhisler için yüksek derecede doğrulukla yorumlayabilmektedir. Kıdemli araştırma görevlisi hekimler tanılarına, tanının doğruluğundan bağımsız olarak, klinik bilgi olmadığı durumda bile güveniyorken, daha az tecrübesi olan araştırma görevlisi hekimler ise klinik bilgi eklendiğinde benzer bir güvene sahip olmaktadırlar.

Anahtar kelimeler: Acil tıp, araştırma görevlisi hekim, klinik bilgi, özgüven, toraks bilgisayarlı tomografisi.

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Introduction

Thoracic CT scans account for 10% of the computed tomographies (CTs) ordered in the emergency departments (EDs) [1]. During the COVID-19 pandemic, admissions to EDs for respiratory tract symptoms have significantly increased, as well as the use of thoracic CT in EDs. Thoracic CT is an imaging tool that is easier to interpret and evaluate than other CTs, and has a significant impact on the clinical decision of new physicians [2].

In overcrowded areas, such as hospital EDs, patients are more likely to undergo laboratory and CT imaging tests [3]. Furthermore, the number of radiologists in the institutions with high patient admissions may be insufficient, and they may not be able to provide service in out-of-hours periods. In some such health institutions, images with teleradiology can be reported by radiologists outside the hospital during non-standard hours [4]. However, this process can be time-consuming. Both the presence of high patient admissions and the necessity of rapid patient evaluation, as well as the limited radiological support, often compels physicians from various specialties to evaluate the radiological images associated with their field. Although there are trainings on the interpretation of radiological images during the residency training process in many educational institutions, radiology residents are usually available in the institutions providing resident training and reporting the CTs. Interestingly, studies show that physicians who graduate from institutions without on-site radiologists and read their own radiographs during their training period have increased self-confidence in patient care after graduation [5].

The aim of this study was to assess the proficiency of ED physicians with varying levels of experience in interpreting thoracic CT, a commonly used imaging method in EDs.

Materials and methods

For the study, ethics committee approval was obtained from Pamukkale University Non-Interventional Clinical Research Ethics Committe. Following the ethics committee approval, all ED residents working in our institution who agreed to participate in the study were included after filling out the informed voluntary consent form. Demographic data of the residents, including their years of experience in the medical profession and in the ED, were recorded. A total of 25 pathological and 5 normal thoracic CT images were prepared by a Radiology specialist with at least 10 years of professional experience. The images were initially presented to the participating ED residents in the computer-based study without providing clinical information. The physicians were then tasked with identifying any pathological findings in these images, determining whether the images were normal or abnormal, and assigning a score out of 10 to represent their confidence level. The thoracic CT diagnoses included 14 cases of viral pneumonias (confirmed COVID diagnosis by PCR), 6 lobar pneumonias, 5 normal, 3 congestive heart failure, 3 traumas and 1 pulmonary embolism. After one month, the same thoracic CT images were shown to the participants with the addition of clinical information and they were asked to identify whether they were pathological or normal once more. Finally, the participants were asked to score their confidence on a scale of 1 to 10.

At the end of the study, the correct identification rates of the residents on the images on thoracic CT and the comparison between seniors and junior residents were described. In our institution, residents who have completed the second year of training in the ED are evaluated with an exam and given the title of "senior resident", if he/she is successful. This title signifies their ability to assume responsibilites within the ED under expert supervision until their graduation.

Statistical analyses

All statistical analyses were performed using SPSS 23.0 (IBM SPSS Statistics 23 (Armonk, NY: IBM Corp.)) software. Continuous variables were defined by the mean ± standard deviation and the median (minimum-maximum values). Kolmogorov Smirnov and Shapiro Wilk tests were used for determination of normal distribution. When parametric test assumptions were met, Independent samples T test was used for comparison between independent groups. Mann Whitney U test was used when parametric test assumptions were not provided. Chi Square test was used for categorical variables. Statistical significance was determined as $p≤0.05$.

Results

Out of the 32 ED residents who participated in the study, 9 (28%) were female. The median age of the participants was 29 years (minimum 24 – maximum 34 years). Among the residents, 20 (62.5%) were classified as junior residents (Table 1). The average duration of residency training in the ED during the study period was 11.35 (±6.16) months for juniors and 38.50 (±8.32) months for seniors. All medical experience was 29.45 (±17.17) months for juniors and 55.33 (±13.59) months for seniors (Table 2).

All 32 participants evaluated all 30 scans. There were no significant differences between the two resident groups in terms of accurate diagnosis rates for images, regardless of the clinical information (*p*=0.307 and *p*=0.061). In pathological diagnoses, there were no discernible differences between the study groups, and the correct diagnosis rates in the presence and absence of clinical information (Table 2). In addition, the physicians' certainty of their own diagnosis mostly does not seem to be statistically different in these diagnoses (Table 3).

Table 1. Identification data of the residents participating in the study

Gender, female, n (%)	9 (28.1)
Age, years	28.69±2.15
Junior resident, n (%)	20 (62.5%)
Residency time in ED, months	21.53±15.04
Experience in medicine, months	39.16±20.20

ED: emergency department, * mean±SD

Table 2. Accurate diagnostic data of senior and junior residents

	Senior Resident	**Junior Resident**	***p***
Gender, female, n (%)	5 (41.7)	4 (20)	0.180
Age, years	30 (29-34)	28 (24-30)	**0.000**
Residency time in ED, months	38.50±8.32	11.35±6.16	**0.000**
Experience in medicine, months	55.33±13.59	29.45±17.17	**0.000**
COVID-19 Dx w/o CI	3.5 (0-12)	5 (0-13)	0.716
COVID-19 Dx with CI	4.5 (0-13)	6 (0-13)	0.924
Viral pneumonia Dx w/o CI	11.5 (4-13)	11 (0-13)	0.924
Viral pneumonia Dx with CI	12 (6-14)	12 (0-14)	0.985
Lobar pneumonia Dx w/o CI	3 (1-5)	3 (0-5)	0.893
Lobar pneumonia Dx with CI	3 (1-5)	3 (1-4)	0.774
Pulmonary embolism Dx w/o CI	1 (0-1)	1 (0-1)	0.408
Pulmonary embolism Dx with CI	1 (0-1)	1 (0-1)	0.893
Congestive heart failure Dx w/o CI	1 (0-3)	1 (0-3)	0.195
Congestive heart failure Dx with CI	1 (0-2)	1 (0-3)	0.893
Trauma Dx w/o CI	2 (1-3)	1 (0-3)	0.125
Trauma Dx with CI	3 (2-3)	3 (2-3)	0.833
Normal CT scan Dx w/o CI	4 (3-5)	4 (0-5)	**0.029**
Normal CT scan Dx with CI	4 (3-5)	2.5 (0-5)	**0.029**
Accurate final Dxs w/o CI	22.08±3.75	19.15±4.33	0.061
Accurate final Dxs with CI	23.5 (20-26)	22 (8-27)	0.307

ED: emergency department, CI: clinical information, CT: computed tomography, Dx: diagnosis, w/o: without, * Chi Square Test
** Independent Samples t-test (mean±SD), *** Mann Whitney U test (median (minimum-maximum))

Table 3. Data for scoring the self-confidence of senior and junior residents at the time of diagnosis

Confidence in	Senior Resident	Junior Resident	p
COVID-19 Dx w/o CI	31.5 (0-113)	41.5 (0-102)	0.985
COVID-19 Dx with CI	39.5 (0-130)	54 (0-119)	0.833
Viral pneumonia Dx w/o CI	99 (40-117)	90 (0-126)	0.116
Viral pneumonia Dx with CI	103 (53-136)	96 (0-121)	0.289
Lobar pneumonia Dx w/o CI	26.42±9.97	22.45±13.25	0.378
Lobar pneumonia Dx with CI	24.33±11.96	21.00±6.13	0.384
Pulmonary embolism Dx w/o CI	8.5 (0-10)	5 (0-10)	**0.024**
Pulmonary embolism Dx with CI	9 (0-10)	8 (0-10)	0.307
Congestive heart failure Dx w/o CI	9 (0-26)	5.5 (0-24)	**0.029**
Congestive heart failure Dx with CI	8 (0-17)	7.5 (0-23)	0.924
Trauma Dx w/o CI	17.17±8.04	10.90±8.83	0.054
Trauma Dx with CI	23.92±5.49	22.10±4.42	0.312
Normal CT scan Dx w/o CI	36.58±7.34	24.25±11.17	**0.002**
Normal CT scan Dx with CI	32.42±9.63	20.40±13.29	**0.011**
Final Dxs w/o CI	268.17±26.35	229.70±36.90	**0.004**
Final Dxs with CI	270.58±32.30	249.50±32.79	0.087

ED: emergency department, CI: clinical information, CT: computed tomography, Dx: diagnosis, w/o: without,
* Independent Samples t-test (mean±SD), ** Mann Whitney U test (median (minimum-maximum))

For normal images, with or without clinical information, senior physicians had higher rates of correct diagnosis in both scenarios (p=0.029) (Table 2). When it was questioned how confident they were about their "normal" diagnosis, senior physicians displayed significantly higher confidence in their own "normal" diagnosis than the junior residents (36.58±7.34 vs. 24.25±11.17; p=0.002). When the clinical information is added, this trend continued favoring the seniors (p=0.011). When all diagnoses are taken into account, the seniors are more confident in the diagnosis of the CT scans they evaluated without clinical information (p=0.004), while when the clinical information is added, the confidence of the junior physicians in their own interpretations of the CT images increases, and there is no longer a significant difference between the two groups (p=0.087) (Table 3).

Discussion

Physicians in departments that primarily handle patients' clinics and frequently assess patients can accurately evaluate the radiological images associated with their fields of expertise [4]. This allows physicians to be more practical in their patient care processes and have greater self-confidence [5]. Emergency

medicine is one such department. In a study evaluating emergency medicine residents, physicians were required to obtain images such as pneumonia, aortic pathology, masses, metastases, pneumothorax, pulmonary embolism, pleural effusion, lung parenchymal pathology, pericardial effusion, mediastinal pathology, cystic lesions in the thoracic CTs, and intraabdomial free fluid, aortic pathology, splenic pathology, intra-abdominal free air, appendicitis, gynecological pathologies, renal pathologies, gallbladder pathologies, mesenteric embolism on abdominal CT. The results have indicated that the ED residents demonstrated similar success rates to radiologists [6]. In the evaluation of head CT scans, ED physicians have been found comparable to neuroradiologists, with no significant oversight of clinically significant patients [7].

Although there are studies that may suggest otherwise [8], it is generally expected that accurate diagnosis rates will improve with increased professional experience. However, professional experience alone is not enough for the radiological evaluation to be accurate. In this study, the rate of correct diagnosis of senior physicians was higher than that of juniors, but although the analysis was not performed because the number of subgroups was limited,

it was evident that the rate of correct diagnosis increased in both groups with the inclusion of clinical information.

The present study was conducted in the first months of COVID-19 in Turkey. The aim of the study was to determine the success of ED residents in interpreting thoracic CT. The images included cases involving trauma patients and many pulmonary emergencies, including viral pneumonias. Notably, during the evaluation, junior residents showed a tendency to diagnose COVID-19, a condition they frequently encountered in daily practice. Another study conducted among radiology physicians (specialists and residents) in the early period of COVID-19 showed that radiologists, even without knowing the patient's clinic, were able to distinguish the diagnosis of COVID-19 with thoracic CT from other viral agents, independent of their professional experience [8]. As professional experience increases, so does self-confidence in decisions [5]. In the study, junior residents were more cautious in their assessments without knowing the patient's clinic. However, they are equally confident as senior residents in the evaluations of patients with their clinical information. This situation once again reveals how important it is to have access to the patient's clinical information.

The study found that junior residents were significantly more cautious than senior ones in making normal thoracic CT diagnosis, and their current diagnosis rates decreased with the addition of clinical information. The reason for this may be multifactorial. Some physicians may hesitate or feel apprehensive to make a normal diagnosis in the presence of a positive clinical information. In addition, some may prefer to evaluate the patient in person before rendering a diagnosis.

The main limitation of the study is the relatively small number of participants. In our institution, as in many EDs, there is an average number of residents. A second limitation is that the number of CT images are insufficient to perform subgroup analysis. These limitations can be addressed in future multicenter studies.

In conclusion, both senior and junior emergency medical residents were able to interpret COVID-19 thoracic CT images with a high degree of accuracy, even though they had no formal training on COVID-19 radiology, during the early stages of the pandemic. Senior emergency medical residents diagnosed thoracic CT images with a high degree of accuracy. Senior physicians were confident in their decisions regardless of whether they are accurate or not, solely by visual inspection, whereas junior residents displayed similar confidence when clinical information was available.

Conflict of interest: No conflict of interest was declared by the authors.

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