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The Effect of a Pandemic on Computed Tomography Pulmonary Angiography Results and Utilize in the Emergency Department

Kadir Kucukceran, Mustafa Kursat Ayranci

Necmettin Erbakan University, Meram School of Medicine,Emergency Department, Konya, Türkiye.

Correspondence Author: Kadir Kucukceran
E-mail: kadirkucukceran@hotmail.com
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ABSTRACT

Objective: The incidence of pulmonary embolism (PE) increases with COVID-19. With the pandemic, changes occur in the utilization of computed tomography pulmonary angiography (CTPA), which we use in the diagnosis of PE. In our study, we investigated the impact of the pandemic on the utilized and result of CTPA.

Methods: Patients over the age of 18 who applied to the emergency department between 01.03.2019 and 28.02.2021 and underwent CTPA was included in this retrospective study. Patients were separated to two groups based on the date of the first case. CTPA result and Polymerase chain reaction (PCR) positivity status were recorded. Data were compared between groups.

Results: While 757(1.022%) out of 74,063 patients underwent CTPA in the pre-pandemic period, 649(1.430%) out of 45,397 patients underwent CTPA in the during-pandemic period. The PE rate in patients who underwent CTPA in the during-pandemic period was statistically significantly higher compared to the pre-pandemic period (pre-pandemic: 89(11.9%), during-pandemic: 122(19%), p<0.001). In the during-pandemic period, there was no statistically significant difference in the rate of PCR positivity in any time in patients with PE detected as a result of CTPA compared to patients without PE (PE: 14(11.5%), non-PE: 54(10.4%), p=0.725).

Conclusion: Higher rate of CTPA shoot was obtained in the during-pandemic period compared to the pre-pandemic period. Additionally, the rate of PE detection among patients who underwent CTPA was statistically significantly higher in the during-pandemic period compared to the pre-pandemic period.

Keywords: COVID-19, Pulmonary embolism, Computed Tomography Angiography, Emergency Department

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a viral disease that starts with symptoms of upper respiratory tract infection (1). Since spreading worldwide, it was considered in the pandemic (2). COVID-19 causes hypercoagulation by causing endothelial damage (3). It was found that the rate of pulmonary embolism (PE) is increased in hospitalized COVID-19 patients and critical care unit COVID-19 patients (4). Although prophylactic anticoagulant therapy, deaths due to PE occurred in COVID-19 patients (5).

Although methods such as D-dimer and echocardiography are used to diagnose PE in the emergency department (ED), the most commonly used diagnostic method is computed tomography pulmonary angiography (CTPA) (6). Along with the pandemic, changes have occurred in ED patient management and the utilization of computed tomography (CT) (7,8). To manage the diagnosis and prophylaxis of PE, which is a life-threatening disease, epidemiological researches are needed to appraise the change in the use of CTPA with the pandemic.

In this study, we analyzed the impact of the pandemic on the utilization and result of CTPA. For this purpose, we examined the utilization of CTPA and the results of CTPA in patients who applied to the ED in the 1-year periods before and after the onset of the pandemic.

2. METHODS

The study was designed as retrospective, observational and single-center. The local ethics committee granted approval for the study (Necmettin Erbakan University Meram Medical Faculty Pharmaceutical and Non-Medical Device Studies Ethical Committee, 2021/3310, 18.06.2021). Patients over the age of 18 who applied to the ED of a tertiary university hospital between 01.03.2019 and 28.02.2021 and underwent CTPA at any time until they left the hospital was included in

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the study. After the pandemic started, the hospital where the study was conducted served both COVİD 19 patients and non-COVID 19 patients. Data were obtained by scanning the CTPA code over the hospital information management system program. Patients whose CTPA not be interpreted due to shooting artifact and/or contrast deficiency were excluded from the study. Although the contrast and shooting method were not optimal, patients whose CTPA was interpreted were included in the study. Patients were separated to two groups based on the date of the first case in the country where the study was conducted (March 2020). The period from 01.03.2019 to 29.02.2020 was named as the pre-pandemic period, and the period from 01.03.2020 to 28.02.2021 was named as the during-pandemic period. Besides, the groups were named as pre-pandemic and during-pandemic.

Age, gender, hospital outcomes (discharge, exitus in-hospital, discharged against medical advice (AMA), and referral), in-hospital mortality status (survivior, non-survivor), length of hospital stay, optimality status of CTPA in terms of contrast and shooting, CTPA shooting status in ED, CTPA result (PE positive, PE negative), localization of the thrombus (if there is PE), bilateral thrombus status (if there is PE), and thrombolytic treatment status were recorded. Additionally, polymerase chain reaction (PCR) positivity in the last 2 weeks and PCR positivity at any time was recorded in the during-pandemic group. It was compared the collected data between groups. The primary aim of the study was to evaluate the frequency of CTPA scans and PE between the two periods. The secondary aim of the study was to compare the PCR positivity rates between those who were diagnosed with PE and those who were not.

SPSS program was used for statistical analysis. Normality analysis of the data was performed. Kolmogorov–Smirnov test was used for this. All quantitative data were not normally distributed. Quantitative and categorical data were expressed as median (Q1 –Q3) and frequency (percentage). The differences between the groups were investigated using the Mann–Whitney U test and chi-square test. For statistical significance, $p<0.05$ was accepted.

3. RESULTS

A total of 74,063 patients over the age of 18 in the pre-pandemic period and 45,397 patients over the age of 18 in the during-pandemic period were admitted to the ED of hospital where the study was conducted. While 757(1.022%) patients underwent CTPA in the pre-pandemic period, 649(1.430%) patients underwent CTPA in the during-pandemic period. In total, 1406 patients underwent CTPA. Fifteen of these 1406 patients were excluded because CTPA not be interpreted due to contrast deficiency and shooting artifact (8 pre-pandemic, 7 during-pandemic). Of the remaining 1349 patients, 749 (53.8%) were in the pre-pandemic group and 642 (46.2%) were in the during-pandemic group. PE was detected in 211 (15.2%) of the patients who underwent CTPA. Additionally, in 274(19.7%) patients, CTPA was not shot in the emergency room, but in the service where they were hospitalized. In-hospital mortality was observed in 230 (16.5%) of the patients included in the study. The data of the patients are given in Table 1 in detail.

Table 1. *The Result of parameters according to the periods*

		All (1391)	Pre-pandemic (749)	During-pandemic (642)	p value
Age		67(55-78)	66(53-77)	70(57-79)	0.001
Length of Hospital Stay (Day)		4(0-12)	3(0-12)	6(1-13)	<0.001
Gender	**Male**	710(51%)	382(51%)	328(51.1%)	0.974
	Female	681(49%)	367(49%)	314(48.9%)	
CTPA shooting location	**ED**	1117(80.3%)	630(84.1%)	487(75.9%)	<0.001
	Admission clinic	274(19.7%)	119(15.9%)	155(24.1%)	
CTPA result	**PE positive**	211(15.2%)	89(11.9%)	122(19%)	<0.001
Contrast enhancement is optimal		1329(95.5%)	721(96.3%)	608(94.7%)	0.161
Hospital Outcome	**Discharged**	1026(73.8%)	580(77.4%)	446(69.5%)	0.001
	Exitus	230(16.5%)	98(13.1%)	132(20.6%)	
	Referral	50(3.6%)	22(2.9%)	28(4.4%)	
	Discharged against medical advice	85(6.1%)	49(6.5%)	36(5.6%)	
In-Hospital Mortality	**Survivor**	1161(83.5%)	651(86.9%)	510(79.4%)	<0.001
	Non-Survivor	230(16.5%)	98(13.1%)	132(20.6%)	

CTPA: Computed tomography pulmonary angiography; ED: Emergency department; PE: Pulmonary embolism.

The PE rate in patients who underwent CTPA in the during-pandemic period was statistically significantly higher compared to the pre-pandemic period (pre-pandemic: 89(11.9%), during-pandemic: 122(19%), p<0.001). In-hospital mortality rate of patients who underwent CTPA in the during-pandemic period was statistically significantly higher compared to the pre-pandemic period (pre-pandemic: 98 (13.1%), during-pandemic: 132 (20.6%), p<0.001). The comparison of the data according to the periods is given in Table 1 in detail.

There was no statistically significant difference between the pre-pandemic period and the during-pandemic period in parameters such as age, gender, hospitalization time, localization of thrombus, in-hospital mortality of patients with PE. However, the rate of bilateral PE detected in the pre-pandemic period was statistically significantly higher compared to during-pandemic period (pre-pandemic: 54(60.7%), during-pandemic: 57(46.7%), p=0.045) (Table 2).

Table 2. *Evaluation of PE patients according to periods*

		All(211)	Pre-pandemic(89)	During-pandemic(122)	p value
CTPA shooting location	ED	154(73%)	65(73%)	89(73%)	0.989
	Admission clinic	57(27%)	24(27%)	33(27%)	
Is embolism bilateral?	Yes	111(52.6%)	54(60.7%)	57(46.7%)	0.045
Localization of thrombus	Subsegmental artery	12(5.7%)	7(7.9%)	5(4.1%)	0.245
	Segmental artery	131(62.1%)	50(56.2%)	81(66.4%)	
	Main and lobar pulmonary artery	68(32.2%)	32(36%)	36(29.5%)	
Thrombolytic Therapy		17(8.1%)	6(6.7%)	11(9%)	0.549
Age		71(57-78)	66(55.5-74.5)	72(58-81)	0.019
Gender	Male	104(49.3%)	42(47.2%)	62(50.8%)	0.603
Length of Hospital Stay (Day)		9(4-17)	10(4.5-16.5)	9(4-17.25)	0.531
In-Hospital Mortality	Survivor	150(71.1%)	68(76.4%)	82(67.2%)	0.146
	Non-Survivor	61(28.9%)	21(23.6%)	40(32.8%)	

CTPA: Computed tomography pulmonary angiography; ED: Emergency department; PE: Pulmonary embolism.

Table 3. *Evaluation of parameters according to CTPA result*

		PE(211)	Non-PE(1180)	P value
Age		71(57-78)	67(55-78)	0.118
Length of Hospital Stay (Day)		9(4-17)	3(0-12)	<0.001
Gender	Male	104(49.3%)	606(51.4%)	0.580
	Female	107(50.7%)	574(48.6%)	
Hospital Outcome	Discharged	132(62.6%)	894(75.8%)	<0.001
	Exitus	61(28.9%)	169(14.3%)	
	Referral	20(4.7%)	40(3.4%)	
	Discharged against medical advice	8(3.8%)	77(6.5%)	
In-Hospital Mortality	Survivor	150(71.1%)	1011(85.7%)	<0.001
	Non-Survivor	61(28.9%)	169(14.3%)	
CT shooting location	ED	154(73%)	963(81.6%)	0.004
	Admission clinic	57(27%)	217(18.4%)	
Contrast enhancement is optimal		207(98.1%)	1122(95.1)	0.050

CTPA: Computed tomography pulmonary angiography; ED: Emergency department; PE: Pulmonary embolism.

The median length of hospital stay of patients with PE detected by CTPA was statistically significantly higher compared to patients without PE (PE: 9(4–17), non-PE: 3(0–12), p<0.001). In-hospital mortality rate of patients with PE detected as a result of CTPA was statistically significantly higher than patients without PE (PE: 61(28.9%), non-PE: 169(14.3%), p<0.001). A detailed comparison of the data according to the result of CTPA is given in Table 3.

In the during-pandemic period, there was no statistically significant difference in the rate of PCR positivity in the last 2 weeks in patients with PE detected as a result of CTPA compared to patients without PE (PE: 7(5.7%), non-PE: 32(6.2%), p=0.863) (table 4). In the during-pandemic period, there was no statistically significant difference in the rate of PCR positivity in any time in patients with PE detected as a result of CTPA compared to patients without PE (PE: 14(11.5%), non-PE: 54(10.4%), p=0.725) (Table 4).

Table 4. *Evaluation of CTPA result with PCR positivity in the during-pandemic period*

	All(642)	PE(122)	Non-PE(520)	P value
PCR positivity in any time	68(10.6%)	14(11.5%)	54(10.4%)	0.725
PCR positivity in the last 2 weeks	39(6.1%)	7(5.7%)	32(6.2%)	0.863

PCR: Polymerase chain reaction; CTPA: Computed tomography pulmonary angiography; PE: Pulmonary embolism.

4. DISCUSSION

In our study, patients who underwent CTPA in the 1-year periods before and after the onset of the pandemic were examined. The rate of CTPA shoot was found to be higher in the during-pandemic period. Additionally, in the during-pandemic period the number of patients with PE detected in patients who underwent CTPA was higher than in the pre-pandemic period.

PE is a life-threatening disease that requires rapid intervention. Due to the relationship between COVID-19 and hypercoagulation, it is thought that its frequency may increase with the pandemic. In this study, the rate of PE detection in the during-pandemic period was statistically significantly higher compared to the pre-pandemic period. In the study by Watchmaker et al., the number of patients with PE detected as a result of CTPA in March-April 2019 was 34, while the number of patients with PE as a result of CTPA in March-April 2020 was 87 (9). In the study by Finn et al., while Pulmonary Embolism Response Team (PERT) consultation was requested from 26 patients in March-April 2019, PERT consultation was requested from 74 patients in March-April 2020 (10). In the same study, PE was detected by CT in 24 patients in March-April 2019, whereas PE was detected by CT in 43 patients in March-April 2020 (10). There may be many reasons for the increase in the incidence of PE with the pandemic. The reason for this increase can be shown as the direct effect of the COVID-19. Because the rate of PE in patients hospitalized due to COVID-19 was found to be higher compared in patients hospitalized for other reasons (11). Additionally, in a meta-analysis of 22 studies by Suh et al., the rate of PE in 3342 COVID-19 patients was found to be 16.5% (12). Espallargas et al. determined that PE detected in COVID-19 patients was predominantly unilateral and on the right side (13). In our study, the rate of bilateral PE in the during-pandemic period was found to be statistically significantly low. This result may be an explanation that the cause of increased PE in the during-pandemic period can be attributed to COVID-19.

In our study, in the during-pandemic period, there was no statistically significant difference in the rate of PCR positivity between patients with and without PE according to the CTPA result. This result is in contrast to the conclusion that the increase in PE may be due to COVID-19. There are studies with similar results in the literature. Freund et al. found similar PCR positivity between 500 patients with PE and 2753 patients without PE in a retrospective multicenter study conducted with 3253 patients who underwent CTPA (14). The reason for this situation be that the pre-diagnosis of PE should be considered more in patients with PCR positivity. For this reason, it may have increased CTPA negativity for PE in patients with PCR positivity. Additionally, the inadequacy in the number of PCR tests during the pandemic process and the fact that a patient who does not have a PCR test even if he/she has COVID-19 can be included in the PCR-negative group also causes this increase. To eliminate this bias in a patient with PCR positivity, studies with prospective and CTPA shot criteria are needed. In the study by Agarwal et al., it was determined that the number of CTPA shoots decreased after the pandemic compared to the pre-pandemic period (8). They thought that the reason for this decrease might be the decrease in ED admission (8). Because we know from the literature that the number of ED admission has decreased during the pandemic period compared to the pre-pandemic period. In the study by Hartnett et al., they found that the number of ED visits decreased by 42% compared to the pre-pandemic period (15). In our study, while the number of CTPA shoots was found to be less in the during-pandemic period, the CTPA shoot rate was found to be higher. The increase in CTPA shoot rate increase the number of patients with PE. However, in our study, the rate of CTPA shoots increased by 39.92% in the during-pandemic period compared to the pre-pandemic period, while the rate of PE detection increased by 59.66% in patients who underwent CTPA (1.022%-1.430%=39.92%; 11.9%-19%=59.66%). In other words, we cannot attribute the increase in PE detection rate only to the increase in CTPA shoot rate.

In our study, statistically significant difference was not found in the in-hospital mortality rates and length of hospital stays of patients with PE in the during-pandemic period compared to the pre-pandemic period. Additionally, the rate of thrombolytic therapy and the localization of the thrombus (segmental, subsegmental) were found to be similar between the two groups in our study. In the study by Finn et al., the length of hospital stays, in-hospital mortality rates and severity of PE (massive-submassive) was found to be similar between the pre-pandemic group and the during-pandemic group (10). However, high mortality rates have been shown in the literature in COVID-19 patients with PE. In a meta-analysis of 8 studies by Liao et al., they found a mortality rate of 45.1% in COVID-19 patients with PE (16). We can explain this contradiction by the small number of patients in our study. Because, although there was no statistical difference in our study, the in-hospital mortality rate was 32.8% in patients with PE in the during-pandemic period, while it was 23.6% in the pre-pandemic period.

This study has some limitations. The fact that the study is retrospective and single-centered is a limitation. Failure to evaluate the CTPA shoot criteria creates a limitation. The inability to explain a clear reason for the difference between the two periods is a limitation. Not evaluating patients receiving anticoagulant prophylaxis is a limitation.

5. CONCLUSION

According to the results of the study, a higher rate of CTPA shoots was obtained in the during-pandemic period compared to the pre-pandemic period. Additionally, the rate of PE detection among patients who underwent CTPA was statistically significantly higher in the during-pandemic period compared to the pre-pandemic period.

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