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RESEARCH ARTICLE

THE INTERPRETATION OF COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY EVALUATION OF COMPLIANCE BETWEEN EMERGENCY MEDICAL ASSISTANTS AND RADIOLOGISTS

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ABSTRACT

Purpose: Computed tomography pulmonary angiography (CTPA) is an effective method far the evaluation of patients with suspected pulmonary thromboembolism (PTE) and should be interpreted quickly and accurately. We aimed ta determine the agreement between emergency medicine assistants (EMAs) and radiology assistants (RA) and specialists (RS) in the evaluation of CTPA
Materials and Methods: 11 EMAs, one RA and one RS participated in the study. 100 CTPA images were re-reported. The participating RA evaluated 100 CTPAs and 11 EMAs evaluated 20 randomised CTPAs aut of 100. The Kappa statistic was used ta assess agreement, and the Douglas G. Altman classifıcation (K<0.20 poor, K: 0.21-0.40 fair, K: 0.41-0.60 moderate, K: 0.61-0.80 good, K: 0.81-1.00 very good) was used ta grade consistency.
Results: The agreement between EMA and RS was 79.1% far the presence of PTE, 59.1% far the location, 84.5% far the parenchymal fınding, 70.0% far the name of the parenchymal fınding. Moderate agreement was found between EMA and RS in the assessment of the presence of PTE (Kappa: 0.590)
Conclusion: There is moderate agreement between EMA and RS in CTPA evaluation.

Keywords: Computed tomography pulmonary angiography, emergency medicine resident, radiologist

INTRODUCTION

PTE develops when the proximal part of a venous thrombus ruptures and causing obstruction of the pulmonary arteries or their branches. Venous thromboembolism is the 3rd most common acute cardiovascular syndrome (1) The annual incidence is between 39-115 per 100000 (2). The wast range of symptoms might delay diagnosis and treatment. Mortality is 25-30% in untreated patients and 2-8% in treated patients (3). Prevailing usage of CTPA has caused increase on diagnosis rates.

Computed tomography (CT) can be considered as one of the most significant devices (4). It is frequently used for PTE in emergency departments.

CTPA visualises thrombi in the pulmonary artery branches up to the subsegmentary level and shows the lung parenchyma, mediastinal structures, pleura and chest wall pathologies (5). The sensitivity and specificity of CTPA for PTE are 83% and 96%, respectively (6). Correct interpretation requires a high level of knowledge and familiarity with the clinical situation. Especially in developing countries, due to technical problems, difficulties in accessing radiology physicians, lack of official reporting and sloppy verbal interpretations, it is essential for emergency physicians to be able to evaluate their imaging studies. In the literature, there are studies evaluating the knowledge and skills of emergency physicians in CT evaluation, but there is no study specifically on CTPA evaluation.

We aimed to determine the agreement between EMA and RA and RS in CTPA evaluation.

MATERIALS AND METHODS

Our study was conducted using CTPA images taken in the emergency department between 1 May 2021 and 30 April 2022 after obtaining ethics committee approval.

12 EMAs that have been employed more than 1 year and finished their rotation in radiology department.11 volunteer EMAs, one RA and one RS participated. Participating EMAs and RAs were informed about the study and consent for participation was obtained.

All patients who underwent CTPA imaging between 1 May 2021 and 30 April 2022 were screened using the hospital information management system. 1826 patients underwent CTPA imaging. Of these, 74 (4.0%) were not reported and 52 (2.8%) were not evaluated due to technical issues. Of the remaining 1700 patients, 111 (6.5%) had filling defects compatible with PTE and 1589 did not. 50 images each with and without PTE findings were selected. This selection was based on the frequency of PTE in different locations, with a higher incidence of PTE in the main pulmonary arteries, which was considered a major error.

From 1 to 100 images were enumbered conformoring to the aquisation date. The normal and abnormal CTPAs were known only by the study authors. The EMAs participating in the study were sorted according to the alphabetical order of their names and coded with letters. CTPAs numbered from 1-100 were written from top to bottom on the EMAs coded with letters. Each EMA was randomised to evaluate 20 images each. All images were re-reported by the RS and the reports were accepted as gold standard. PTE was detected in 3 of the 50 CTPAs that were considered normal before re-reporting. Therefore, the participants evaluated 47 normal and 53 abnormal CTPAs, which was different than planned.

Identity and clinical information of the patients were not given to the participants in the study. All 100 images, including coronal, axial and sagittal sections, were shown to the RA and 20 images to the EMAs using Picture Archiving and Communication Systems from the monitors in the emergency department. No assistance from any other assistant or specialist was obtained during the evaluation of the images. Participants were asked to write down each pathology seen, its type and localisation on the study form.

The study data recording and evaluation form was used for the records. The pathologies written by the EMAs and RA on the evaluation form and the pathologies in the RS report were marked as "present" or "absent" on the evaluation form. The assessment of "presence of pathology" or "absence of pathology" by both parties was considered concordant; the assessment of "presence of pathology" by one party and "absence of pathology" by the other party was considered discordant.

In case of "suspected pathology" in the RS report, this was not included in the concordance assessment.

All statistical analyses of the data were performed in SPSS 25.0 for Windows with 95% confidence interval and 0.05 significance level. Nominal and ordinal data were described by frequency analysis. Age averages were described with mean and standard deviation values. Kolmogorov Smirnov test was performed for normality analysis of age distribution. Since the distribution was normal, Independent Sample t-test was used to analyse the difference between the groups with and without PTE. Fischer's Exact test was used to analyse the difference between the group with and without PTE in terms of gender. The Kappa statistic was used in order to evaluate the agreement with the aquired data. Douglas G. Altman classification (K<0.20 poor, K: 0.21-0.40 fair, K: 0.41-0.60 moderate, K: 0.61-0.80 good, K: 0.81-1.00 very good) was used for consistency grading. Spearman's rho correlation analysis was performed for the relationship between

Table 1. Age and gender distribution of the groups

	Pulmonary thromboembolism		p value
	Absent (n=47; %47)	**Present (n=53; %53)**	
Age, mean ± SD	60.02±17.02	66.57±15.39	0.046[a]
Gender, n (%)			
Male	19 (40.4)	29 (54.7)	0.110[b]
Female	28 (59.6)	24 (45.3)	

a. Independent sample t-test, b. Fischer's Exact Test, SD: Standard Deviation.

Table 2. Comparison of EMA assessments with RS report

	Compatibility (%)	Kappa	Douglas G. Altman Classification
Pulmonary thromboembolism	% 79,5	0,590	Moderate
Truncus	% 97,2	-0,12	Poor
Right main pulmonary	% 91,3	0,768	Good
Left main pulmonary	% 91,8	0,740	Good
Right lobar	% 79,5	0,523	Moderate
Left lobar	% 84	0,570	Moderate
Right segmentary	% 75,4	0,476	Moderate
Left segmentary	% 81,3	0,583	Moderate
Right subsegmentary	% 65,9	0,298	Fair
Left subsegmentary	% 70,9	0,353	Fair
Parenchymal finding	% 86,8	0,719	Good
Atelectasis	% 88,6	0,236	Fair
Ground-glass opacification	% 89	0,593	Moderate
Consolidation	% 90,4	0,577	Moderate
Effusion	% 89	0,634	Good

emergency medicine resident professional seniority and compliance

RESULTS

Between 01.05.2021 and 30.04.2022, PTE was absent in 47% and present in 53% of the BTPAs selected for the study from the BTPA images taken in the emergency department.The mean age of the group without PTE (60.02±17.02) was statistically significantly lower than the mean age of the group with PTE (66.57±15.39) ($p<0.05$). While 40.4% of the group without PTE was male and 59.6% was female, 54.7% of the group with PTE was male and 45.3% was female. Between the groups, no major diffferncе with ot without PTE in terms of gender is examined. ($p>0.05$) (Table 1).

The ages of the non-PTE group were between 20 and 89 years, while the ages of the PTE group were between 30 and 93 years. The age range of the non-PTE group was 69 years and 63 years in the PTE group.

Among the EMAs in the study, 36.4% had 1 to 2 years, 36.4% had 2 to 3 years and 27.3% had 3 to 4 years of professional experience. PTE agreement between EMA and RS was 79.1%, location agreement was 59.1%, the agreement of the presence of parenchymal finding was 84.5% and

Table 3. Comparison of RA assessments with RS report

	Compatibility (%)	Kappa	Douglas G. Altman Classification
Pulmonary thromboembolism	% 98	0,960	Very good
Truncus	% 100	1,00	Very good
Right main pulmonary	% 100	1,00	Very good
Left main pulmonary	% 100	1,00	Very good
Right lobar	% 100	1,00	Very good
Left lobar	% 100	1,00	Very good
Right segmentary	% 100	1,00	Very good
Left segmentary	% 100	1,00	Very good
Right subsegmentary	% 98	0,960	Very good
Left subsegmentary	% 99	0,980	Very good
Parenchymal finding	% 100	1,00	Very good
Atelectasis	% 100	1,00	Very good
Ground-glass opacification	% 100	1,00	Very good
Consolidation	% 100	1,00	Very good
Effusion	% 100	1,00	Very good

the agreement of the parenchymal finding was 70.0%.

Moderate agreement was found between EMA and RS in the evaluation of the presence of PTE. The highest agreement was seen in the right main pulmonary artery. Good agreement was found in the left main pulmonary artery and moderate agreement was found in the right and left lobar arteries. Agreement was moderate in bilateral segmentary arteries and poor in bilateral subsegmentary arteries. Good agreement was observed between EMAs and RS in parenchymal findings. Agreement in parenchymal findings was lowest in the atelectasis finding and highest in the effusion finding. Moderate agreement was found between RS and EMAs for ground glass and consolidation (Table 2).

There was 73.75% agreement for the presence of PTE in those with a professional seniority of 1-2 years. The degree of agreement was moderate (Kappa: 0.473, Douglas G. Altman K: 0.41-0.60 moderate). In the same group, very good agreement was found in the evaluation of parenchymal findings (Kappa:0.813, Douglas G. Altman K: 0.81-1.00 very good). There was 86.25% and good agreement for the presence of PTE in EMAs with a professional seniority of 2-3 years (Kappa: 0.722, Douglas G. Altman K: 0.61-0.80 good). There was good agreement for parenchymal findings (Kappa: 0.691, Douglas G. Altman, K: 0.61-0.80 good). In EMAs with a professional seniority of 3-4 years, the agreement was moderate for PTE and good for parenchymal findings (Kappa: 0.564 and 0.625, Douglas G. Altman, K: 0.41-0.60 moderate, K: 0.61-0.80 good). No truncal PTE was detected in any CTPA in the groups with 2-3 years and 3-4 years of seniority, so the kappa value could not be calculated. According to Spearman's rho correlation analysis, the professional experience of the EMAs did not show a statistically significant effect on compliance assessment.

Agreement between RA and RS was 98.0% for PTE, 97.0% for location, 100.0% for the presence of a parenchymal finding and 100.0% for the name of the parenchymal finding. Excellent agreement was seen in all localisations (Table 3).

DISCUSSION

In the literature, different agreement rates have been reported between EMAs and RS in the

evaluation of radiological imaging. In a study by Aydın et al. in which 5 EMA and RA were performed, good agreement was found (Kappa: 0.773) (7). The lower agreement rate compared to this study may be because of the difference in training and experience between the evaluators and the large percentage of false negatives. In our study, false negatives were common in subsegmentary arteries. Güven et al. found that the rate of CT interpretation by emergency physicians for PTE was 89.4% and the agreement with the final results was moderate (Kappa: 0.590) (4).

Hochhegger et al. compared the agreement rates between RAs and emergency physicians for PTE detection (8). In this study, the agreement between RAs and RSs was found to be very good, and between RSs and emergency physicians was found to be moderate, similar to our study.

In a study by Cervini et al. in which 840 CTPAs were examined in two different centres, the preliminary interpretation of the on-call RA and the RS report were compared, and 90% agreement was found (P = .76, 95% confidence interval, 0.71-0.81) (9). In our study, the agreement between RA and RS was 98% for the presence of PTE. In the study by Cervini et al. the agreement between RA and RS was lower than in our study due to the multisite comparison of cTPAs and the inclusion of a large number of patients and RA.

In our study, the highest agreement was 94.8% for left subsegmentary arteries, while the lowest agreement was 65.9% for right subsegmentary arteries. One of the reasons for the low agreement in subsegmentary arteries compared to other locations may be the lack of careful evaluation due to the perception that the presence of PTE in subsegmentary arteries, which are usually caught incidental in daily practice, do not give clinical findings and have a low hospitalisation rate, is not important.

Although the agreement rate in truncal evaluation was 97.2%, the kappa value was -0.12. In our study, 4 PTEs detected in the trunk in 100 CTPAs were not detected by EMAs, while 2 false positive truncal PTEs were detected. Although the correct interpretation of CTPAs, 98.2% of which were negative in terms of truncal PTE, increased the percentage of agreement, it can be said that EMAs are insufficient to evaluate PTE in the trunk. This is one of the unexpected results of the study. In a study in which thrombus locations were evaluated in CTPA, PTE in the trunk was found to be only 3.0% and 2.4% in Duru et al. study (10), (11). Because of its infrequent occurrence, it can be said that EMAs are not accustomed to this anatomical location and cannot make an accurate assessment. PTE in the trunk may be confused with PTE in the main pulmonary arteries. This is not because PTE was not recognised, but because the location was misjudged.

In our study, the agreement in terms of the presence of parenchymal findings was 84.5%, while the agreement in terms of the parenchymal findings was 70%. It can be said that the finding seen more prominently in some images with more than one parenchymal finding causes other findings that will not lead to a change in the treatment process to be ignored.

In the studies of Arhami et al. and Perron et al. no relationship was found between the number of years spent in the profession and radiological evaluations, similar to our study (12), (13).

Limitations

Since CTPAs were scanned retrospectively, our study is not a study reflecting the clinical environment. In practice, in cases of intermediate cases, the diagnosis and treatment process of patients progresses by consulting the specialists. This study was conducted only for the evaluation of EMAs.

CONCLUSION

In our study, the agreement between EMA and RS was 79.1% for the presence of PTE, 59.1% for the location, 84.5% for the presence of parenchymal finding and 70.0% for the name of the parenchymal finding. Moderate agreement was found between EMA and RS in the assessment of the presence of PTE. There was poor agreement in the pulmonary trunk, good agreement in bilateral main pulmonary arteries, moderate agreement in bilateral lobar and segmental arteries and poor agreement in bilateral subsegmental arteries. Good agreement was observed in the evaluation of parenchymal findings. There was poor agreement for atelectasis, moderate agreement for ground glass and consolidation, and good agreement for effusion. Agreement between RA and RS was 98.0% for PTE, 97.0% for location, 100.0% for parenchymal findings and 100.0% for the name of the parenchymal finding.

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