Radiological Findings of Patients with Acute Pulmonary Embolism in a Sample of Iraqi Patients

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ABSTRACT

Background: Pulmonary embolism is common and associated with significant morbidity and mortality, with often non-specific clinical presentations. The diagnosis of pulmonary embolism depends highly on imaging studies, which may also provide prognostic information.

Objectives: To evaluate radiological findings of patients with acute pulmonary embolism.

Methods: A cross-sectional study done in teaching hospitals in Baghdad, during the period from 1st March 2023 to 1st January 2024, for patients who were diagnosed with pulmonary embolism by computed tomography pulmonary angiography (CTPA). The data were collected from 100 patients admitted to the cardiac care unit, general medical and surgical wards of Alyarmouk, Al-Imam Al-Kadhimein and Baghdad Medical City teaching hospitals. Different parameters were taken, such as age, sex. chest X-ray, echocardiography, and CTPA were taken for all the patients.

Results: One hundred patients with pulmonary embolism, who aged 53.9 ± 16.2 years (females constituted of 77.0% of the cases) were included. Chest X-ray findings revealed prominent central pulmonary artery (Fleischer sign; 51.0%) and evidence of emboli. Central emboli on CTPA were found in 62.0%. Central emboli reported in 83.9% of the females, and the initial thrombolysis treatments was reported in 36% of cases.

Conclusions: The pulmonary emboli were significantly more common in females than males. The prominent pulmonary vessels were the most common radiological features of PE, and the central emboli were more common CTPA findings than the peripheral ones.

Keywords: Radiological findings, Acute pulmonary embolism, Iraqi patients.

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Pulmonary embolism (PE) is an occlusion of the pulmonary arteries, which most frequently occurs due to migration of a deep vein thrombosis (DVT) from the lower extremities through the right heart[1]. Acute pulmonary embolism (PE) ranks third in cardiovascular-related mortality following coronary artery disease (CAD) and stroke, with an annual incidence of 115 per 100,000 population[2]. The mortality rate associated with this condition is exceptionally high[3].

In the United States, an estimated 370,000 PE cases were reported in 2016[4]. Patients were classified as high-risk PE if they were considered to be having cardiac arrest or cardiogenic shock, according to the most recent European Society of Cardiology (ESC) and European Respiratory Society (ERS) guidelines[5]. Patients with persistent hypotension, which was not coded as cardiogenic shock, were not included in this analysis. Diagnosing PE via conventional chest radiography (CXR) is impractical due to nonspecific findings like atelectasis and pleural effusion common in many other chest pathologies. Approximately 12 to 22 % of PE cases show normal CXR results[6]. Although uncommon and rarely seen, radiologists should also be vigilant for classical PE signs on CXR. These include Hampton hump (wedge-

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shaped opacification usually found at the lung periphery representing pulmonary infarction distal to the pulmonary embolus). Westermark sign (a discrete area of opacification secondary to oligemia distal to the pulmonary artery site occluded by the embolus). Fleischner sign (prominence seen at the right hilum on CXR due to the enlarged central pulmonary artery caused by a massive PE). Chang sign (abrupt dilatation of main pulmonary artery due to acute pulmonary embolism). Palla sign (sausage-shaped, enlarged right descending pulmonary artery) and Knuckle sign (abrupt tapering of the pulmonary artery occluded secondary to the embolus)[7].

Echocardiographic findings in pulmonary embolism can be broadly divided into the following categories: anatomic findings (thrombi in transit), measures of chamber size, measures of function and global/regional contractility, and Doppler-derived estimates of regurgitation, pressure and resistance[8]. The availability of mobile echocardiography devices, equipped with 2D and colour Doppler imaging, has made echocardiographic signs, sometimes in combination with lung ultrasound, a valuable bedside tool when pulmonary CTA and/or full echocardiographic studies are not available[9]. CT pulmonary angiography (CTPA), also commonly known as CT angiogram with contrast, is a preferred gold standard imaging method for diagnosing PE due to its high sensitivity (96–100 %) and specificity (89–98 %)[10]. A CTPA involves a helical CT scan with a 40-60 mL bolus of low- or iso-osmolar iodinated contrast agent injected intravenously at a rate of 3-6 mL per second into the patient[11]. Hence, a recent meta-analysis of CT accuracy for the diagnosis of PE reported pooled estimates for CTPA sensitivity and specificity of 94% and 98% respectively[12]. CTPA is widely available and can be rapidly performed in and out of office hours with a high sensitivity and specificity. Additional advantages are the identification of alternate diagnoses and, for confirmed PE, evaluation for radiological features of right heart strain[13].

This study aimed to evaluate radiological findings of patients with acute pulmonary embolism

Methods

The current cross-sectional multi-centers study was conducted in the coronary care units at the general medical and surgical wards at Alyarmok, Al-Imamein Al-Kadhimein and the Medical City Hospitals in Baghdad, during the period between March 2023 and January 2024. One hundred patients (total number) were enrolled in the study; all those patients were admitted with acute PE, which was confirmed by clinical assessment, echocardiography and computed tomographic pulmonary angiography (CTPA).

The criteria of inclusion are: patients aged >17 years old, confirmed diagnosis of PE supported by clinical and radiological findings using the Wells criteria[14], which composed of total score 12.5. Patients with missing data due to refusal to participate in the study or critically ill patients.

The obtained demographic and clinical data were age, sex, smoking, site of admission (inpatient or outpatient), predisposing factors (hypertension, diabetes mellitus), bedridden, long-time trip, recent surgery, pregnancy, contraceptive pills users, hematological diseases, solid malignancies and the personal or family history of venous thrombosis. Each patient underwent a clinical assessment, especially for vital signs, oxygen saturations, lower limb unilateral swelling, jugular venous pressure, cardiac findings, in addition to the following investigations: complete blood count, biochemical determinants, electrocardiography, echocardiography, CXR and CTPA. Chest X ray was taken for each patient to look for any pleural effusion, atelectasis, oligemia, Westermark sign, Hampton’s hump, and enlargement of the pulmonary vasculature shadowing. CTPA is done to confirm PE diagnosis and to look for the lung vessels involvement whether central or peripheral, depending on the report from the radiologist. In the central

type of PE, the involvement may be to the trunk or the main right or main left pulmonary artery, while in the peripheral type of PE, the involvement is divided into the segmental or sub-segmental branch. The examination was completed with a caudal-cranial breath-hold CTPA without deep inspiration in order to avoid a transient interruption of contrast[15], with intravenous administration of 50 ml of iodinated contrast medium at 4 to 5 ml/s followed by a flush of 20 ml of physiological saline solution using a bolus-tracking technique. The CT chest report was recorded by a radiologist.

Continuous variables were expressed as means and standard deviations. Categorical variables were expressed as frequencies and percentages. The Welch's t-test (for normally distributed variables) and Wilcoxon rank-sum test (Mann-Whitney test) (for non-normally distributed variables) were performed to test the difference in means and medians, respectively. The difference between categorical variables was investigated using either the chi (χ^2) test with Yates' correction or Fisher's exact test, depending on the context. A P value less than 0.05 was considered statistically significant. Statistical Package for the Social Sciences (SPSS, IBM) version 26 was used for statistical analysis.

Results

One hundred patients participated in the study, with a mean ± SD age of 53.9 ± 16.2 years. The sex distribution was 77 (77%) females and 23 (23%) males. Pulmonary embolism incidents occurred more often outside the hospital setting (71%) than within (29%), Co-morbidities included hypertension (46.0%), diabetes mellitus (35.0%), and ischemic heart disease (17.0%) were observed. A smaller percentage of participants had a history of stroke, chronic obstructive pulmonary disease and 9% had a previous history of venous thromboembolism, (Table 1).

Table 1: The characteristics of the participants.

Characteristic	Results
Age (years)	53.9 ± 16.2
Gender	
Females	77 (77)
Males	23 (23)
Place of occurrence	
Outside	71 (71)
Hospital	29 (29
History of co-morbidities	
Hypertension	46 (46)
Diabetes mellitus	35 (35)
Ischemic heart disease	17 (17)
Stroke	9 (9)
Asthma	6 (6)
Chronic obstructive pulmonary disease	5 (5)
Interstitial lung disease	3 (3)
Previous history of venous thromboembolism	9 (9)

The results are presented as mean ±SD, and number (%).

Chest X-ray findings revealed that the most common features included a prominent central pulmonary artery (Fleischer sign) in 51.0% of cases, atelectasis in 46.0%, pleural effusion in 38.0%, pleural-based opacity (Hampton hump) in 28%, oligemia (Wester mark sign) in 15% and normal X-rays in 14.0%. Pulmonary artery involvement by CTPA was detected in 33% of the main arteries, 29% of the lobar arteries, 36.0% in segmental arteries, and 2% in the subsegmental arteries. In terms of the emboli sites on CTPA, 62% were central, and 38.0% were peripheral. Furthermore, lung involvement on CTPA showed bilateral-sided in 66.0% of cases, right-sided in 26.0%, and left-sided, (Table 2 and Figure 1).

Echocardiography revealed significant proportions of patients with right ventricular enlargement (88%) and tricuspid regurgitation (88%), indicating the impact on cardiac function. Additionally, right ventricular dysfunction (tricuspid annular plane systolic excursion (TAPSE)) (20%) and right ventricular hypokinesia (18%) were noted. Right ventricular systolic pressure (RVSP) had a mean value of 43.7 ± 13.6 mmHg, with 66% of patients having an RVSP ≥ 40 mmHg and 34% with an RVSP < 40 mmHg, (Table 3).

Table 2: Chest X-ray and CTPA findings in patients with pulmonary embolism.

Characteristic	No. (%)
Chest X-ray findings	
Prominent central pulmonary artery (Fleischer sign)	51 (51)
Atelectasis	46 (46)
Plural effusion	38 (38)
Plural based opacity (Hampton hump)	28 (28)
Oligemia (Westermark sign)	15 (15)
Normal	14 (14)
Pulmonary artery involvement on CTPA	
Main	33 (33)
Lobar	29 (29)
Segmental	36 (36)
Subsegmental	2 (2)
Location of emboli on CTPA	
Central (the trunk, main right. or main left pulmonary artery)	62 (62)
Peripheral (segmental or subsegmental)	38 (38)
Lung involvement on CTPA	
Bilateral	66 (66)
Right side	26 (26)
Left side	8 (8)

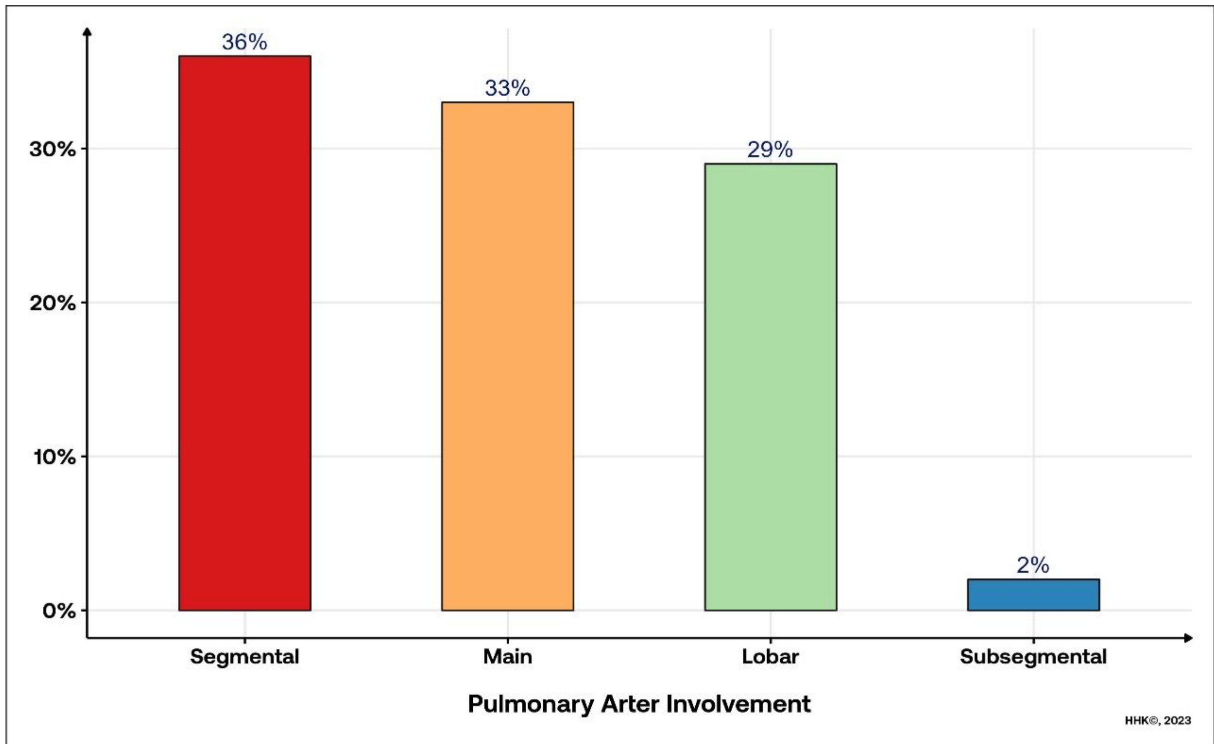

Figure 1: Pulmonary artery involvement distributions.

Table 3: Echocardiography findings.

Characteristic	Results
Right ventricular enlargement	88 (88)
Tricuspid regurgitation	88 (88)
Right ventricular dysfunction	20 (20)
Right ventricular hypokinesia	18 (18)
Right ventricular systolic pressure (mmHg)	43.7 ± 13.6
≥40mmHg	66 (66)
<40mmHg	34 (34)
Normal	8 (8.0)

The results are expressed as mean ± SD, and a number (%).

Regarding the relation between central and peripheral PE, the investigation unveiled key disparities between these groups. Notably, patients in the central group had a higher mean age of 57.3 years compared to 48.3 years in the peripheral group, with a statistically significant p-value of 0.007.

Gender distribution also varied, for central group females were (83.9%) and

male (16.1%), but in peripheral group females were (65.8%) and males were (34.2%), with a statistically significant difference (p value 0.037).

Various comorbidities and risk factors were assessed, and their implications on PE were examined. Hypertension and diabetes mellitus were more prevalent in the central group with a statistically significant difference. There is no significant statistical difference between the central and peripheral groups regarding the other risk factors.

Regarding symptoms and signs and severity classification of lung involvement by CTPA, there was no statistically significant difference between the two groups, while for vital signs, only diastolic blood pressure was lower in the central group with statistically significant (p= 0.023), (Table 4).

Table 4: Relationship between central and peripheral pulmonary embolism regarding study parameters.

Characteristic	Central (N = 62)	Peripheral (N = 38)	p-value
Age (years)	57.3 ± 15.5	48.3 ± 16.0	**0.007**
Gender			**0.037**
Females	52 (83.9)	25 (65.8%)	
Males	10 (16.1)	13 (34.2%)	
Co-morbidities			
Hypertension	34 (54.8)	12 (31.6)	**0.023**
Diabetes mellitus	26 (41.9)	9 (23.7)	**0.063**
Ischemic heart disease	12 (19.4)	5 (13.2)	0.4
Stroke	6 (9.7)	3 (7.9)	0.94
Asthma	4 (6.5)	2 (5.3)	0.92
Chronic obstructive pulmonary disease	4 (6.5)	1 (2.6)	0.6
Interstitial lung diseases	1 (1.6)	2 (5.3)	0.6
Previous history of venous thromboembolism	7 (11.3)	2 (5.3)	0.5
Lung involvement on CTPA			
Bilateral	40 (64.5)	26 (68.4)	0.7
Right side	16 (25.8)	9 (23.7)	0.8
Left side	6 (9.7)	2 (5.3)	0.7
Right ventricular systolic pressure (mmHg) on echocardiography	44.2 ± 13.3	42.9 ± 14.2	0.6

The results are presented as mean ± SD and a number (%);
P-values were calculated using Welch two-sample t-test, Pearson's Chi-squared test, and Fisher's exact test.

For the RVSP, the analysis showed no significant difference in age between the two groups (RVSP <40 group and RVSP ≥40 group), with mean ages of approximately 51.8 and 54.9 years, respectively. Gender distribution showed no significant difference, with a slight female predominance. The place of occurrence showed a difference, as more cases occurred outside the hospital in the RVSP ≥40 Group. Co-morbidities and risk factors displayed no statistically significant disparities. Furthermore, clinical presentation, signs at presentation, chest X-ray findings, and the sites of emboli were explored. Notably, chest pain was more prevalent in the RVSP ≥40 group with a statistically significant difference. Bilateral lung involvement on CTPA showed a predominance in those with RVSP ≥40 (p = 0.048), while left side involvement was more in RVSP <40 (p = 0.018), (Table 5).

Table 5: Right ventricular systolic pressure (RVSP) difference according to the demographic and clinical data

Characteristic	RVSP <40 (N = 34)	RVSP ≥40 (N = 66)	p-value
Age (years)	51.8 ± 16.2	54.9 ± 16.2	0.4
Gender			0.4
Female	28 (82.4)	49 (74.2)	
Male	6 (17.6)	17 (25.8)	
Place of occurrence			0.054
Outside	20 (58.8)	51 (77.3)	
Hospital	14 (41.2)	15 (22.7)	
Co-morbidities			
Hypertension	13 (38.2)	33 (50.0)	0.3
Diabetes mellitus	8 (23.5)	27 (40.9)	0.084
Ischemic heart disease	5 (14.7)	12 (18.2)	0.7
Stroke	3 (8.8)	6 (9.1)	0.97
Asthma	2 (5.9)	4 (6.1)	0.95
COPD	0 (0.0)	5 (7.6)	0.2
ILD	1 (2.9)	2 (3.0)	0.92
History of VTE	3 (8.8)	6 (9.1)	0.90
Chest X-ray findings			
Prominent central PA	15 (44.1)	36 (54.5)	0.3
Atelectasis	19 (55.9)	27 (40.9)	0.2
Plural effusion	14 (41.2)	24 (36.4)	0.6
Plural-based opacity	8 (23.5)	20 (30.3)	0.5

Characteristic	RVSP <40 (N = 34)	RVSP ≥40 (N = 66)	p-value
Normal	4 (11.8)	10 (15.2)	0.8
Oligemia	4 (11.8)	11 (16.7)	0.5
Embolism location			0.2
Central	18 (52.9)	44 (66.7)	
Peripheral	16 (47.1)	22 (33.3)	
Lung involvement on CTPA			
Bilateral	18 (52.9)	48 (72.7)	**0.048**
Right side	10 (29.4)	16 (24.2)	0.6
Left side	6 (17.6)	2 (3.0)	**0.018**
Severity			0.2
Low	3 (8.8)	1 (1.5)	
Intermediate	19 (55.9)	36 (54.5)	
High	12 (35.3)	29 (43.9)	

The results are expressed as mean ± SD and a number (%).
P values were calculated using Welch two sample t-test, Pearson's chi-squared test and Fisher's exact test.

Discussion

In the current study, 100 patients with confirmed pulmonary embolism were enrolled, revealed that the average age of the participants was 53.9 ± 16.2 years. In Thoddi et al., study[16], the mean age was 50 years. Regarding gender, in this study females were 77% and males 23%. In Lindsey et al., study[17], the percentage of females was also higher (52%). The high rate of pulmonary embolism in females may be related to pregnancy, puerperium[18], and using oral contraceptive pills[19]. The majority of pulmonary embolisms occurred outside the hospital (71.0%), in Wanis et al. study[20] also the majority outside the hospital (68.6%). Regarding the history of co-morbidities, hypertension was the most common (46.0%), in Dieuwke et al.[21] study, hypertension was the most common co-morbidity (44.0%).

The chest X-ray findings in this study, revealed that the most common features included a prominent central pulmonary artery (Fleischer sign) in 51.0% of cases, atelectasis in 46.0%, pleural effusion in 38.0% and normal X-rays in 14.0%. These results agreement with multiple previous studies, in that, the X-rays often are abnormal in 88%, as in Ali Zubairi et al., study in Pakistan 2007[22]. Fleischer sign occurs most commonly in the setting of large pulmonary embolism (Angio-graphically as involving 50% or more of the major pulmonary artery branches), but has a relatively low sensitivity in diagnosis[23]. In Hatice et al study[24], a normal chest X-ray can be seen in pulmonary embolism, which can determine mortality and may increase the risk of massive pulmonary embolism. In Nuria et al. study[25], 23.8% of patients with pulmonary embolism have pleural effusion. Wanis et al study[20] pleural effusion (25.4%) and atelectasis (21.6%). Nevertheless, due to these findings are all non-specific and not useful in making a definite diagnosis of acute PE, so no clear explanation to the causes of variability in the prevalence of each finding, so major

role of the X-ray is to identification of alternative disease processes that can mimic thromboembolism.

Computed tomography pulmonary angiography is considered the first-line diagnostic technique in patients with suspected PE, with sensitivity and specificity values between 96 and 100% and between 89 and 98%, respectively[26]. In terms of emboli location on CTPA in this study, 62.0% were central, and 38.0% were peripheral, 36.0% in segmental arteries, in agreement with Omran Al Dandan, et al study in Al-Khobar, Saudi Arabia 2020[26], it revealed that the central PE were found in 63.5% of the cases and 31 (36.5%) were peripheral. Regarding the pulmonary artery involvement on CTPA the main 33 (33.0%), lobar 29 (29.0%), segmental 36 (36.0%), subsegmental 2 (2.0%), in Dieuwke et al study[21] central 85 (35%), lobar 9 (4%), segmental 107 (44%), subsegmental 41 (17%). In this study, lung involvement on CTPA was bilateral in 66 (66.0%), right-sided 26 (26.0%), and left-sided 8 (8.0%). In Wanis et al. study[25], 64.1% had bilateral PE, and 23.8% had unilateral right-sided PE. In the current study, the echocardiography revealed significant proportions of patients have findings suggesting PTE, tricuspid regurgitation (88.0%), indicating the impact on cardiac function, nearly similar to the result of Eid et al., study (2022) tested in Egypt, revealed that 60% have tricuspid regurgitation[27]. Notably, the present study revealed that the patients in the central group pulmonary embolism had a higher mean age of 57.3 years compared to 48.3 years in the peripheral group with a statistically significant difference. These findings compare with those obtained in a previous study by Jose Martinez et al, was tested in Navarra Spain 2016[28], the patients with central pulmonary embolisms were mostly the elderly and the age was higher than the age of patients with peripheral pulmonary embolisms.

In this study, the rate of hypertension and diabetes mellitus (DM) was more among patients with central group PE. In comparison with multiple previous studies, the relationship between the history of DM and the severity of the disease in patient with PE was well established. In Gulru Polat study in Research Hospital, Izmir, Turkey 2022[29], which reveals that, the patients with DM were more vulnerable to develop a massive PE, but no clear evidence in these studies about the type of PE whether central or peripheral. The highly suggested explanations are the hypercoagulable state with many coagulations and metabolic abnormalities. In Muhammad Yousaf, et al. trial in Iraq 2023, the hypertension was present in 36% of PE patients[30]. One of the limitations in this study is that the ventilation perfusion scan data were not included; it has an established role in diagnosis and prognosis for patients with acute PE.

In conclusion, the pulmonary emboli are significantly more common in females than males. The prominent pulmonary vessels are the most common radiological features of PE, and the central emboli were more common CTPA findings than the peripheral ones

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