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Frequency and Anatomical Distribution of Pulmonary Embolism on CT Pulmonary Angiography

Muhammad Ishaq [1], Muhammad Zakir[1], Shahid Rasool[1], S Muhammad Yousaf Farooq[1], Jawad Ahmed[2], Wajahat Ali[3], Usman Ali[4], Haider Zaman[5], Rabia Ansar[6], Zain Abdul Khaliq[7]
University Institute of Radiological Sciences & Medical Imaging Technology, The University Of Lahore, Pakistan

Abstract
Background: Pulmonary embolism, with its growing prevalence, has become a potentially life-threatening medical condition with crucial symptoms. However, prognosis is good if timely diagnosis is made and to the level of segmental and sub segmental arteries as well. Standard computed tomography pulmonary angiography (CTPA) is thus used to diagnose acute pulmonary embolism.
Objective: The primary objective of the current study was to determine and investigate the anatomical distribution frequency of pulmonary emboli, where segmental, sub segmental, and lobar arteries on CT pulmonary angiography are included.
Methodology: In a descriptive cross-sectional study, single-centered studies and CTPA scans of 98 patients were included. Data was obtained from Shalimar Hospital and University of Lahore – Teaching Hospital, Lahore, Pakistan. Sample size included patients of all age groups with suspected pulmonary embolism, with no differentiation of male or female samples.
Results: According to statistics and analysis, the current study results indicated the presence of pulmonary embolism in 36 patients and its absence in 62 patients. Results indicated that amongst the 98 patients scanned, the highest frequency of pulmonary emboli was found in the pulmonary trunk and lobar artery in 8 patients (8.2%). Furthermore, CTPA of the participants detected pulmonary emboli in segmental and sub-segmental arteries of 5 patients (5.1%), with another 2 patients showing pulmonary emboli in only the sub-segmental artery (2.0%). Another 2-2 patients showed pulmonary emboli in lobar and segmental artery and lobar, segmental and sub-segmental artery respectively (2.0%, 2.0%).
Conclusion: The largest number of pulmonary emboli were found in the pulmonary trunk, followed by emboli of segmental and lobar arteries in patients. It is concluded that CTPA evaluates pulmonary embolism with great precision and anatomical distribution localized main trunk, and pulmonary artery emboli along with lobar, segmental and sub-segmental artery emboli.
Keywords: Computed Tomography Pulmonary Angiography (CTPA), pulmonary emboli, segmental artery, sub segmental artery, lobar arteries
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INTRODUCTION

The principal circulation system of the pulmonary network consists of the pulmonary arterial tree, extensive capillary bed and pulmonary venous tree, associated in sequences becoming a truncated pressure and high capacitance circulatory structure that delivers a larger superficial space utilized for exchange of gases. Pulmonary vascular anatomy consists of vessels (arteries and veins) providing the lungs including pulmonary arteries, pulmonary veins, and bronchial arteries[1].Apart from these, segmental and subsegmental pulmonary arteries run parallel to the bronchi and supply the bronchopulmonary segments, named according to the location of these arteries. As for the subsegmental veins, they run within interlobular septa and congregate to form right, left, superior and inferior pulmonary veins which drain into the left atrium[2]. These are not parallel to the segmental or sub segmental pulmonary artery branches and bronchi. There are substantial anatomic variations in number or presence of accessory vessels, particularly in the upper lobes[1]. Comprehension and information on ordinary and variation anatomy on cross-sectional and angiographic pictures is fundamental for exact finding of vascular pathology and aids the preparation of surgical, diagnostic and interventional procedures[3].

Pulmonary embolism also termed as the deep vein thromboembolism is a is a relatively common, acute cardiovascular and pulmonary medical condition with vital clinical significance due to its potentially dangerous characteristics and is a major reason of morbidities and mortalities in effected individuals of all age mostly acquiring of adults[4]. Being the topic of concern in the current study, pulmonary embolism is a medical condition where a blood clot or a thrombus becomes lodged in the pulmonary arteries (single or multiple) in the lungs, blocking the flow of blood to the area supplied by the artery. The disorder typically ascends through a thrombus instigating in the deep venous system of the lower extremities; nevertheless, it on the odd occasion also originates in the pelvic, renal and upper extremity veins, which is detached and embolized to the pulmonary circulation[5].

Pulmonary embolism is a blockage of pulmonary arteries caused by clots of blood, hence an acute condition[3], due to which patients mostly present in emergency departments of hospitals with a variety of clinical symptoms, typically sudden in onset and inclusive of dyspnea that is shortness of breath, tachypnea or rapid breathing, and a chest pain of pleuritic nature that is normally worsened by breathing, cough and hemoptysis[6]. While little and detached aspiratory emboli do not cause a lot of hemodynamic changes, the focal and bigger pneumonic emboli increment pneumonic vascular obstruction and right ventricular afterload, which might accelerate right ventricular disappointment as discussed above, leading to cardiogenic shock[7]. More extreme cases can incorporate markers like cyanosis or the pale blue staining of fingers and nails, breakdown of the respiratory framework, and circulatory insecurity on account of diminished blood course through the lungs[8]. Notwithstanding exceptional advances in the diagnostic checkup and criteria, rates of survivals after a patient have gone through intense PE actually differ broadly, with transient endurance going from seventy-one percent to ninety-five percent and survival rates that are long-term range from sixty-one percent to seventy-five percent[9]. Thus, it is a clinical need to foster a method for fast and certain risk separation and management in patients with pulmonary embolism to work on both short and long haul survival[10].

As it is clearly known that, CT pulmonary angiography (CTPA) was introduced in the mid-1990s, and subsequently this technology demonstrate the ability to detect peripheral or subsegmental PE[11]. CT scans are more commonly available 24 hours a day for seven days a week, making them more reliable than nuclear medicine studies. In addition, CTPA diagnostic algorithms are simpler and able to depict smaller, larger and all kinds of pulmonary embolisms along with pulmonary, pleural, mediastinal, and chest wall lesions that may cause symptoms similar to those of PE[12]. With all these profound attributes, CTPA has become the most common procedure for the diagnosis of PE. Although CTPA studies are carried out by following the same technique, each of the radiology department carrying out the imaging will have a slightly different method for achieving the same outcome, which is the adequate enhancement of the pulmonary trunk and its branches in order to rule out pulmonary embolism[13].The best results are obtained using multidetector computed tomography (MDCT) scanners[11]. Moreover, studies have not considered the distribution of pulmonary embolism in patients and have conflicting results regarding the anatomic distribution of PE[14]. Therefore, in this study, the main objective is to evaluate the anatomic distribution of PE through CTPA in consecutive number of patients clinically suspected of having PE, with special emphasis on the largest pulmonary arterial branch (i.e., lobar, segmental, or subsegmental).[15]

Pulmonary embolism is a common and fatal condition associated with significant morbidity and mortality in untreated patients. Prompt and accurate diagnosis of PE greatly influences the outcome and prognostic conditions of patients. Tragically, the clinical determination of pulmonary embolism is troublesome, on the grounds that indications are regularly ambiguous and vague, prompting misdiagnosis. Computed tomographic pneumonic angiography is a powerful method for clinical conclusion of embolism, where the technique enjoys upper hands over ventilation perfusion filter due to its immediate imaging of the blood coagulation, better between spectator understanding, more prominent exactness, and probability to clarify patient's sign and indications. However sizes of emboli either large or small are misdiagnosed on CTPA. Therefore, the determination of anatomic positioning and the frequency distribution of pulmonary embolism, whether segmental, sub segmental, and lobar arteries is important. The major aim of this study thus relies on this discussion.

Method

In a descriptive cross-sectional study, single-centered studies and CTPA scans of 98 patients were included. Data was obtained from Shalimar Hospital and University of Lahore – Teaching Hospital, Lahore, Pakistan. Sample size included patients of all age groups with suspected pulmonary embolism, with no differentiation of male or female samples.

RESULTS

Table 1: Frequency of patients in different Age Groups

AGE (Years)	Frequency	Percent
14 -24 Years	3	3.1
25 -35 Years	11	11.2
36 -45 Years	16	16.3
46 -55 Years	15	15.3
56 -65 Years	27	27.6
66 - 75 Years	14	14.3
76 - 85 Years	12	12.2
Total	98	100.0

Total 98 patients of different age groups were included in the study, where 3 patients (3.1%) were between 14-24 years old, 11 (11.2%) were between 25-35 years old, 16 (16.3%) were between36-45 years old. Moreover, 15 patients (15.3%) were between 46-55 years old, 27 (27.6%) were between 56-65 years old, 14 (14.3%) were between 66-75 years old and 12 (12.2%) were between 76-85 years old

Pie Chart 1: Age

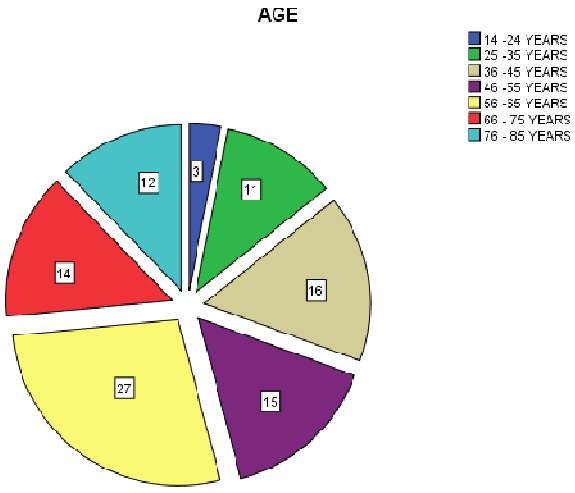
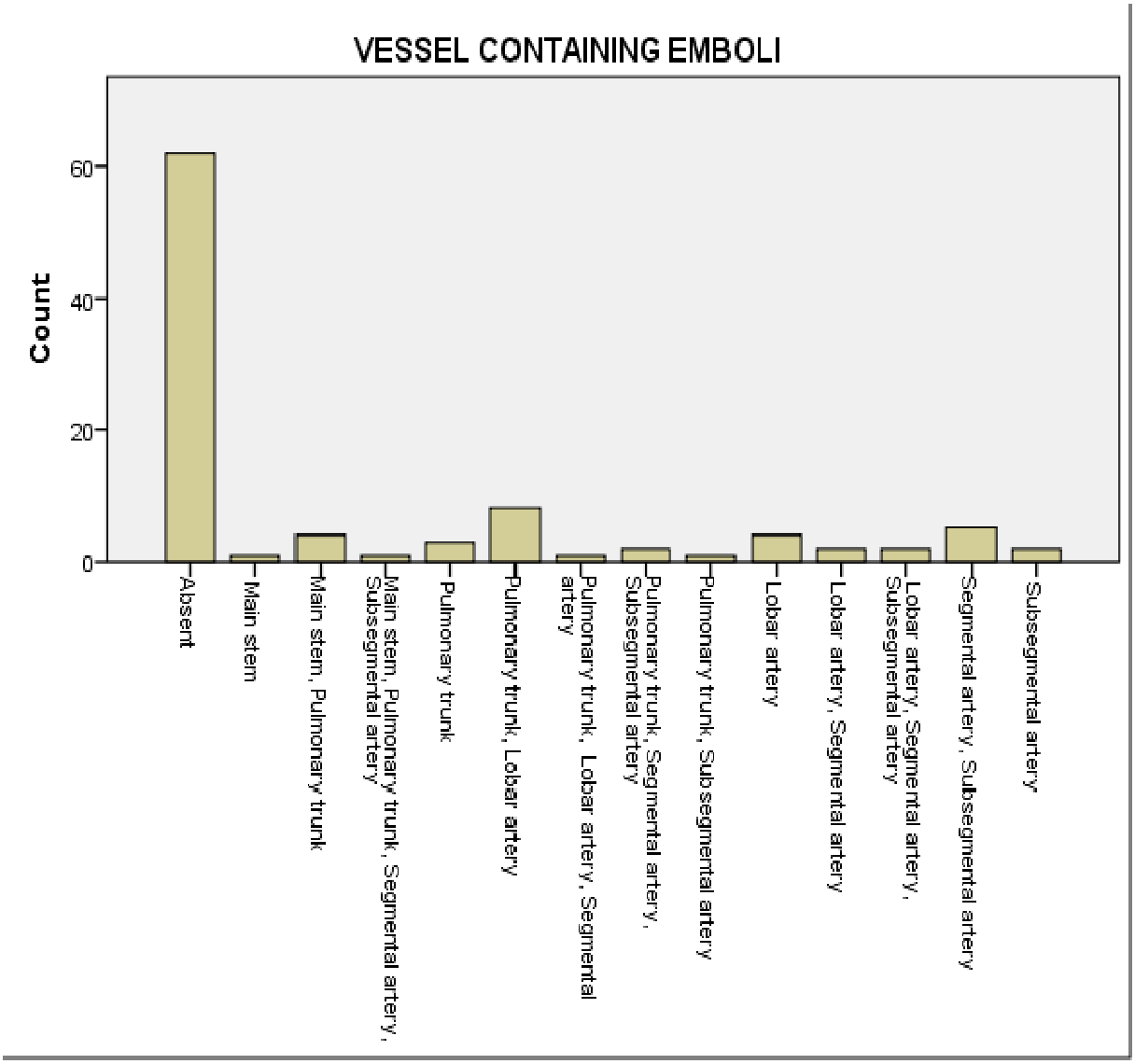


Table 6: Frequency of Vessel containing Emboli

	Frequency	Percent
Main stem	1	1.0
Main stem, Pulmonary trunk	4	4.1
Main stem, Pulmonary trunk, Segmental artery, Subsegmental artery	1	1.0
Pulmonary trunk	3	3.1
Pulmonary trunk, Lobar artery	8	8.2
Pulmonary trunk, Lobar artery, Segmental artery	1	1.0
Pulmonary trunk, Segmental artery, Subsegmental artery	2	2.0
Pulmonary trunk, Subsegmental artery	1	1.0
Lobar artery	4	4.1
Lobar artery, Segmental artery	2	2.0
Lobar artery, Segmental artery, Subsegmental artery	2	2.0
Segmental artery, Subsegmental artery	5	5.1
Subsegmental artery	2	2.0

Total 98 patients were scanned among them 62(63.3%) were normal while in 1 (1.0%) patient pulmonary embolism was present only in Main stem. Other 4 (4.1%) patient pulmonary embolism were present in Main stem and pulmonary trunk, while in 1 (1.0%) patient pulmonary embolism were present in Main stem and pulmonary trunk, Segmental artery and Subsegmental artery. On the other hand, in 3 (3.1%) patient pulmonary embolism were present only in Pulmonary trunk, while in 8 (8.2%) patient pulmonary embolism were present in Pulmonary trunk and Lobar artery, in 1 (1.0%) patient pulmonary embolism were present in Pulmonary trunk, Lobar artery and Segmental artery. In 2 (2.0%) patient pulmonary embolism were present in Pulmonary trunk, Segmental artery and Subsegmental artery, while in 1 (1.0%) patient pulmonary embolism were present in Pulmonary trunk and Subsegmental artery, while in 4 (4.1%) patient pulmonary embolism were present in Lobar artery, while in 2 (2.0%) patient pulmonary embolism were present in Lobar artery and Segmental artery. In 2 (2.0%) patient pulmonary embolism were present in Lobar artery, Segmental artery and Subsegmental artery, while in 5 (5.1%) patient pulmonary embolism were present in Segmental artery and Subsegmental artery and in 2 (2.0%) patient pulmonary embolism were present in only Subsegmental artery.



DISCUSSION

The current study aims at the estimation and evaluation of pulmonary embolism and the anatomic distribution of emboli on CT angiography. The study sample consisted of ninety-eight patients of all age groups with suspected pulmonary embolism. Scans of each of these patients were evaluated and results were compiled using the SPSS software of data analysis. The study results are discussed in this chapter.

The study findings provide a newfangled understanding of Computed Tomography Pulmonary Angiography (CTPA) with findings on the frequency distribution of emboli according to the arteries and areas of presence of embolism. The study results indicate that amongst the ninety-eight patients scanned, the highest anatomic frequency of pulmonary emboli was found in the pulmonary trunk and lobar artery in a total number of eight patients (8.2%). Furthermore, CTPA of the participants detected pulmonary emboli in segmental and subsegmental arteries of five patients (5.1%), with another two patients showing pulmonary emboli in only the subsegmental artery (2.0%). Another two-two patients showed pulmonary emboli in lobar and segmental artery and lobar, segmental and subsegmental artery respectively (2.0%, 2.0%). The existence of pulmonary emboli were detected efficiently to the level of segmental and subsegmental arteries in the scans of patients, thus, signifying the findings of the current study.

Moreover, the results indicated an age-wise frequency of patients presenting pulmonary embolism at the time of scan and the highest frequency was found in patients of ages between 66 to 75 years (total of 8 patients). Whereas, younger age groups 36 to 45 years and 46 to 55 years were also found prevalent to the disease, according to the current study findings. Nevertheless, more than half of the patients were not diagnosed with pulmonary embolism at CTPAs, indicating normal scans.

The current study findings correlate to a number of studies conducted in the light of estimation of

frequencies of pulmonary embolism according to their locations, anatomy and the arteries of presence. All such studies and their findings signify the results and findings of current study and highlight the numerous attempts made to assess the contribution of CTPA to the diagnosis of pulmonary embolisms[16, 17]. The study results associate with those of Safriel and Zinn (2002) and show that computed tomography for pulmonary embolism is a valuable diagnostic instrument with an overall high sensitivity and specificity[18].

Correspondingly, Kritsaneepaiboon et al., (2009) carried out a similar study and localized pulmonary emboli in lobar pulmonary artery in12 (39%), the segmental pulmonary artery in 11 (35%), the subsegmental pulmonary artery in five (16%) patients[19]. Excluding the groups wise localization of pulmonary emboli in the current study, pulmonary emboli in lobar, segmental and subsegmental arteries were localized in seventeen patients and the presented scans. The study results can be discussed in a way that all CTPA scans and studies were practically and technically visualizing and localizing arteries to the level of lobar and segmental arteries; however, the estimation of subsegmental pulmonary arteries was a bit limited and seen in about nine of the scans.Oser et al., (1996) declared similar findings where upper lobe pulmonary emboli frequency was 60. The frequency of emboli in the lobar artery was 14, declaring it the largest arterial branch with PE[20]. The study also localized some emboli at segmental level; however, the images and details are vague for subsegmental level.

The current study with advanced CTPA images and findings localizes to the minimal extent of PE. Additionally, unlike other studies on the topic, the current study also highlights the number of normal patients in the scans, providing data on the prevalence of pulmonary emboli in the study population. According to these statistics, PE was prevalent in 36.7% of the study population and absent in 63.3%. Nevertheless, the prevalence cannot be declared for a general Pakistani population because of the small sample size and the study design as well.

Apart from the anatomic frequency findings, statistics and analysis displayed results on the side of lungs involved and the bilateral and unilateral presence of pulmonary emboli on CTPAs. Right lung was effected in 7 patients (7.1%) and left lung was effected in 4 patients (4.1%). Whereas, 25 patients (25.5%) displayed the disease in both of the lungs. As for unilateral and bilateral appurtenance of the condition, 11 patient displayed unilateral findings while 25 patients showed bilateral emboli findings. The study results were also significant and vital as the most minuscule details, mentioned above, were found through analysis.

CONCLUSION

The current study was performed to determine and investigate the anatomical distribution frequency of pulmonary emboli, where segmental, sub segmental, and lobar arteries on CT pulmonary angiography were included. The results revealed a precise and through frequency distribution of pulmonary emboli and depicted both larger and smaller emboli with utmost probability. The frequency distribution showed lobar, segmental and subsegmental artery emboli and indicated that CTPA was the gold standard for diagnosis of smaller PE.

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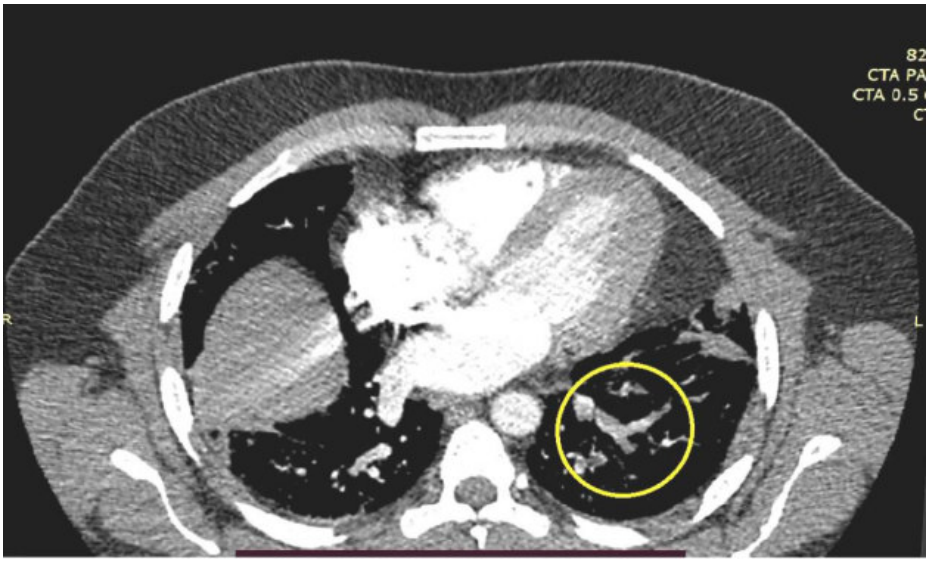
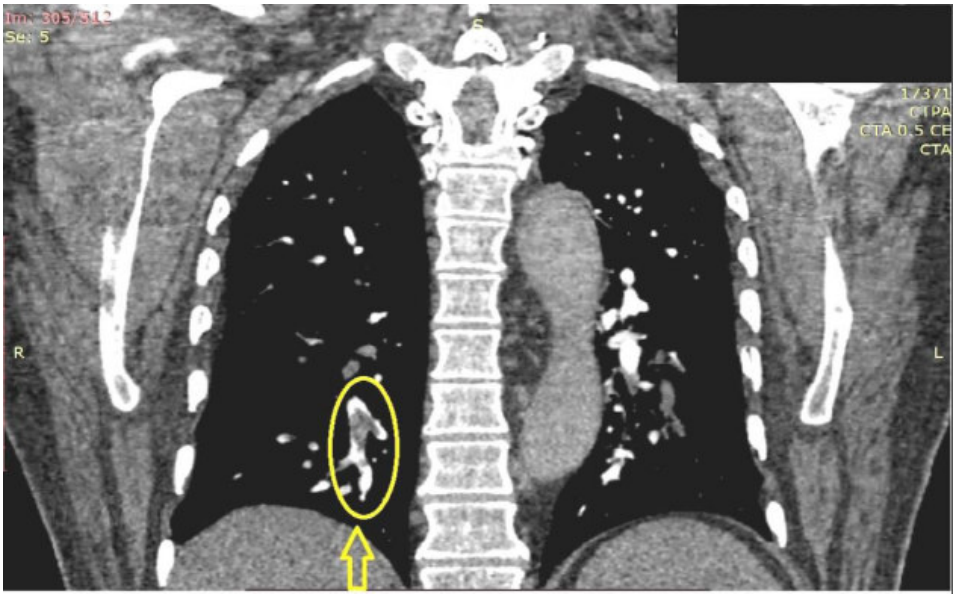
Case no 1:



Computed tomography pulmonary angiography displaying a pulmonary artery emboli (encircled in yellow circle).

Case no 2:



Computed tomography pulmonary angiography displaying a segmental artery pulmonary emboli (encircled in yellow circle).

Case no 3:

Computed tomography pulmonary angiography displaying a segmental artery pulmonary emboli (encircled in yellow circle).