ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

ORIGINAL RESEARCH

Correlation of Computed Tomographic Obstruction Index and 2D Echocardiography in Pulmonary Thromboembolism

[1]Dr. P. Kavitha, [2]Dr. D. Harinath, [3]Dr. K. Radha Rani, [4]Dr. V. Vandana

[1]Assistant Professor, [2]Associate Professor, [3]Professor and HOD, Department of Radiodiagnosis, Kurnool Medical College, Kurnool, Andhra Pradesh, India.
[4]Consultant Radiologist, Sai Scan Centre, Kurnool, Andhra Pradesh, India.

Corresponding author
Dr. V. Vandana
Consultant Radiologist, Sai Scan Centre, Kurnool, Andhra Pradesh, India.

Received: 20 April, 2023 Accepted: 23 May, 2023

Abstract

Background: This study was conducted to calculate the pulmonary arterial obstruction index (Qanadli index), evaluate its usefulness in patients with pulmonary thromboembolism, study the correlation between the pulmonary arterial obstruction index and right ventricular dilatation in patients with pulmonary thromboembolism, and investigate the correlation between the pulmonary artery obstructive index and right ventricular dysfunction in patients with pulmonary embolism.

Methods: This was a hospital based cross-sectional study conducted among 50 patients who presented with pulmonary thromboembolism to the Department of Radiodiagnosis and Imageology, Kurnool Medical College, Kurnool, over a period of two years from November 2018 to November 2020, after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Results: Dyspnea and chest pain were present in 78% and 40% of the patients respectively. The maximum number of patients had an obstructive pulmonary index. Thrombus in the RT main pulmonary artery was present in 24 % of patients. LT main pulmonary artery in 18%. RT upper lobe segmental artery involved in 50%, RT middle lobe segmental artery in 72%, RT lower lobe segmental artery in 74%. LT upper lobe segmental artery involved in 36%, LT middle lobe segmental artery in 56%, LT lower lobe segmental artery in 62%. RT lung was involved more than LT lung. RV dilation measured in terms of relation to right and left ventricular measurements, RV/LV > 1 was present in 40%, <1 in 60%. RV dilatation was present in 20 patients out of 50. Out of 20 patients, 19 had a pulmonary artery obstructive index >45%; only one had a pulmonary artery obstructive index <45%. RV dysfunction was present in 19 cases. 15 patients had a pulmonary artery obstructive index >50%; four patients had a pulmonary artery obstructive index <50%.

Conclusion: The specific index (the CT obstruction index) to quantify vascular obstruction in helical CT appears simple and reproducible. The CT obstruction score has considerable clinical and imaging impact, enabling accurate diagnosis, risk stratification, and patient selection for more aggressive treatment. There is a strong correlation between OI, RV dilatation, and RVD.

Keywords: Computed Tomographic, Obstruction Index, 2D Echocardiography, Pulmonary Thromboembolism.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

Introduction

Pulmonary Embolism (PE) is a fatal and common form of venous thromboembolism that causes about 300,000 deaths annually, usually in patients with unstable hemodynamic status.[1] Patients with unrecognized acute PE have an estimated mortality rate of 30%.[2]If pulmonary embolism is diagnosed at the right time, the death rate can be reduced to 3-10%. So the rapid establishment of a diagnosis of PTE is essential for the initiation of life-saving thrombolytic therapy. Although CT pulmonary angiography is the gold standard for the diagnosis of PTE, its disadvantages, including its invasiveness, costliness, unavailability in every medical center, and associated risks, make the use of non-invasive diagnostic methods important.

The use of helical and multi-detector computed tomographic angiography(CTA) is a priority in PTE's therapeutic plans due to multiple advantages, such as more rapid accessibility, non-invasiveness, higher consensus among interpreters, better compliance by significantly hemodynamically impaired patients, and quicker diagnostic yield. Computed Tomography Pulmonary Angiography(CTPA) is currently the method of choice for the evaluation of acute pulmonary embolism.[3]

CTPA has a specificity of about 95% for identifying clots within the distal pulmonary arteries. Also, CT pulmonary angiography can help clinicians in the diagnosis of underlying lung diseases. CT pulmonary angiography can also assess clot burden using scoring systems such as the Pulmonary Artery Obstruction Index (PAOI). Acute PE increases the pulmonary arterial system's pressure and right ventricle(RV), resulting in right ventricular dysfunction(RVD). RV dysfunction, followed by PE, usually causes death within the first hour following admission to the hospital.[4] Although 2D-echocardiography is currently the modality of choice for RVD diagnosis, CTPA can replace echocardiography because of its ability to detect PE, assess right ventricular dilatation, and predict right ventricular dysfunction simultaneously.[5]

The pulmonary arterial obstruction index provides objective results and establishes thrombi, and their weight may be calculated with CTPA.[6] PAOI is a parameter calculated by combining the degree of the stenosis diameter, which is created by the thrombotic material, and the number of segmental arteries distal to the thrombotic occlusion. The burden (i.e., thrombus weight) of the thrombi, then, can be determined, and therapy can be shaped accordingly.[7] A correlation is seen between total clot load on the proximal pulmonary artery, obstruction of the arterial bed, and right ventricular dysfunction.

Aims and Objectives

- To calculate the pulmonary arterial obstruction index (Qanadli index) and evaluate its usefulness in patients with pulmonary thromboembolism.
- To study the correlation between the pulmonary arterial obstruction index and right ventricular dilatation in patients with pulmonary thromboembolism.
- To investigate the correlation between the pulmonary artery obstructive index and right ventricular dysfunction in patients with pulmonary embolism.

Methods

This was a hospital based cross-sectional study conducted among 50 patients who presented with pulmonary thromboembolism to the department of Radio-Diagnosis and Imageology, Kurnool Medical College, Kurnool, over a period of two years from November 2018 to November 2020, after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

Inclusion Criteria

For the study, we only considered patients with positive CTPA.

Exclusion Criteria

1. Previous allergic reactions to contrast media.
2. Patients with a known history of cardiac and pulmonary diseases.
3. Inability to provide informed consent(e.g., severe dementia).
4. Pregnancy and lactating mothers.
5. Renal failure.
6. Patients over the age of 60 years.

Statistical Methods

The data was entered in MS Excel and analysed using SPSS software. Results were presented as tables.

Results

Age Group (in years)	**Frequency**	**Percentage**
20-30	9	18%
31-40	11	22%
41-50	26	52%
>50	4	08%
Age Distribution		
Gender	**Frequency**	**Percentage(%)**
Males	32	64%
Females	18	36%
Total	50	100%
Sex Distribution		
Table 1. Demographic Distribution		

The maximum number of patients were between the age groups of 41-50 years (52%), then 31-40 (22%),20-30(18%), >50 (8%). There was a male preponderance (64%) in our study compared to females (36%) with a female-to-male ratio of 1:1.125.

Dyspnea	**Frequency**			**Percentage**
Present	39			78%
Absent	11			22%
Total	50			100%
Dyspnea as Symptom				
Chest Pain	**Frequency**			**Percentage**
Present	20			40%
Absent	30			60%
Total	50			100%
Chest Pain as Symptom				
PAOI	5-10	11-20	21-30	31-40
Frequency	6	25	19	0
Percentage	12%	50%	38%	0
Pulmonary Arterial Obstruction Index Distribution				
Table 2				

Dyspnea and chest pain were present in 78% and 40% of the patients respectively. The maximum number of patients had an obstructive pulmonary index between 11-20(50%),

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

then 21-30(38%), 5-10(12%).

	Frequency	**Percentage**
RT Main Pulmonary Artery	12	24%
LT Main Pulmonary Artery	09	18%
Total	21	42%
Main Pulmonary Arteries Involvement		
	Frequency	**Percentage**
RT Upper Lobe Segmental Artery	25	50%
RT Middle Lobe Segmental Artery	36	72%
RT Lower Lobe Segmental Artery	37	74%
Segmental Artery Distribution in Right Lung		
	Frequency	**Percentage**
LT Upper Lobe Segmental Artery	18	36%
LT Middle Lobe Segmental Artery	28	56%
LT Lower Lobe Segmental Artery	31	62%
Segmental Artery Distribution in Left Lung		
Table 3		

Thrombus in RT main pulmonary artery was present in 24 % of patients.LT main pulmonary artery in 18%. The right pulmonary artery was involved more when compared to the left central pulmonary artery.

RT upper lobe segmental artery was involved in 50%, RT middle lobe segmental artery in 72%, and the RT lower lobe segmental artery in 74%.

LT upper lobe segmental artery was involved in 36%, LT middle lobe segmental artery in 56%, and the LT lower lobe segmental artery in 62%.

	Right		**Left**	
	Frequency		**Frequency**	
	N	**(%)**	**N**	**(%)**
Upper Lobe	25	(50%)	18	(36%)
Middle Lobe	36	(72%)	28	(56%)
Lower Lobe	37	(74%)	31	(62%)
Comparison of Segmental Arteries Distribution on Either Side				
RV/LV Ratio	**Frequency**		**Percentage**	
>1	20		40%	
<1	30		60%	
Total	50		100%	
Right Ventricular Dilatation				
PAOI	**RV Dilatation Present**		**RV Dilatation Absent**	**Total**
PAOI > 45%	19		0	19
PAOI <45%	01		30	31
Total	20		30	50
Correlation of RV Dilatation and PAOI				
Table 4				

The RT lung was involved more than the LT lung. RV dilation measured in terms of relation to right and left ventricular measurements, RV/LV > 1 was present in 40%, <1 IN 60%. That is, right ventricular dilatation was present in 20 patients.

RV dilatation was present in 20 patients out of 50 patients. Out of 20 patients, 19 had a pulmonary artery obstructive index >45%; only one patient had a pulmonary artery

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

obstructive index <45%.

RV Dysfunction	**Frequency**	**Percentage**	
Present	19	38%	
Absent	31	62%	
Total	50	100%	
Right Ventricular Dysfunction			
PAOI	**RV Dysfunction Present**	**RV Dysfunction Absent**	**Total**
>50 %	15	5	20
<50%	04	26	30
Total	19	31	50
Correlation of RV Dysfunction and PAOI			
Table 5			

RV dysfunction was present in 19 patients (38%) out of 50 patients. Out of 19 patients, 15 patients had pulmonary artery obstructive index >50%; four patients had a pulmonary artery obstructive index <50%

Discussion

In our study, the peak age of presentation of pulmonary thromboembolism was between the ages of 40-50 years with male predominance. The main presenting symptoms were dyspnea, cough followed by chest pain, hemoptysis; most patients had more than one symptom as a presenting symptom. Central pulmonary arterial involvement was noted in 21(42%) patients. Among them, the right main pulmonary artery was involved in 12(24%), and the left main pulmonary artery was involved in 9(18%) patients. In the rest of 24 patients, segmental arteries are involved. In our study, the majority of patients had a pulmonary artery obstructive index in the range 11-20.

Right ventricular dilation was seen in 20 patients (40%). Out of 20 patients with right ventricular dilatation, 19 had a pulmonary artery obstructive index >45%; only one patient had an obstructive index <45%, with sensitivity and specificity of 95% and 96% respectively.

Right ventricular dysfunction was seen in 19 patients (38%). Out of 19 patients with right ventricular dysfunction, 15 patients had a pulmonary artery obstructive index >50%, and four patients had an obstructive index <50%.

In our study, the maximum number of patients was in the interval of 41-50, i.e., 52%; in between 31-40 (22%); in between 20-30(18%); >50 years was 8%. The mean age of presentation was 40.1 years. This is unlike other studies done by Mustafa Goketal., Massimo Miniate et al., B.S. Praveen Kumar et al., where the mean age was 64.1, 61 and 47.1 respectively. This may be because we excluded patients over the age of 58, who had risk factors for pulmonary and cardiac diseases. The risk of pulmonary thromboembolism increases with age. For every ten years after age 60, the risk of having PE doubles.

In our study of 50 patients, 64% were male, and 36% were female. But according to the literature, pulmonary thromboembolism is equal in males and females, and in many studies, it is more common in females than in men.

In our study, dyspnea was present in 78% of patients, making it the most common presenting symptom in most patients. This is comparable to studies done by Massimo Miniati et al.(78%), B.S. Praveen et al. (94.3%), and Noha M. Attia et al.[8](74.28%).

In our study, chest pain was present in 40% of patients, making it the second most common presenting symptom in most patients. This is comparable to studies done by Massimo Miniati et al.(39%), B.S. Praveen et al.(45.7%), and Noha M. Attia et al.(62.85%).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

Pulmonary Artery Obstructive Index Distribution

In our study, the maximum number of patients had PAOI between 11-20(50%), 38% of patients had PAOI between 21-30, 12% had PAOI <10, none had >31.

In our study, central or main pulmonary artery involvement was seen in 42% of patients, similar to other studies. In a study by M. Higazi et al., the central pulmonary artery was involved in 46% of cases. In a study by Attia et al., the central pulmonary artery was involved in 45% of cases; in a study by BS Praveen Kumar et al., it was involved in 60% of cases.

Segmental/Subsegmental Artery Distribution

In our study, segmental and subsegmental artery involvement was seen in 58% of patients, similar to other studies. In studies done by M. Higazi et al., Attia et al., and BS Praveen et al., segmental and subsegmental arteries were involved in 54%, 55%, 40% of cases respectively.

Comparison Statistics of Cut-Off Value of PAOI to Predict RV Dilation

In our study, RV dilatation was present in 20 patients out of 50 patients. Out of 20 patients, 19 had a pulmonary artery obstructive index >45%; only one patient had a pulmonary artery obstructive index <45%.

This is comparable with Taraneh et al., and M. Hijazi's et al. studies, whose cut-off values were >40% and >47%, respectively. Hence, right ventricular dilatation can be predicted by using a cut-off obstructive pulmonary index of 40%.

Comparison Statistics of Cut-Off Value of PAOI to Predict R V Dysfunction

In our study, RV dysfunction was present in 19 patients out of 50 patients. Out of 19 patients, 15 patients had a pulmonary artery obstructive index >50%; four patients had a pulmonary artery obstructive index <50%. This is comparable with studies done by Attia et al., Rodrigues et al.,[9] Guo et al.,[10] whose cut-off values were 43%, 46%, 52%, respectively. Hence, right ventricular dysfunction can be predicted by using a cut-off obstructive pulmonary index of 50%.

Conclusion

The introduction of MDCT pulmonary angiography has considerably changed the approach to PE. It is currently the method of choice as it is available, rapid, sensitive, and allows adequate visualization of the pulmonary artery clots up to the segmental level, besides adding to its ability to exclude alternative diagnoses. The specific index (the CT obstruction index) to quantify vascular obstruction in helical CT appears simple and reproducible. The CT obstruction score has considerable clinical and imaging impact, enabling accurate diagnosis, risk stratification, and patients' selection for more aggressive treatment. There is a strong correlation between OI, RV dilatation, and RVD.

References

1. Marshall PS, Mathews KS, Siegel MD. Diagnosis and management of life-threatening pulmonary embolism. J Intensive Care Med 2011;26(5):275-94.
2. Nagamalesh UM, Prakash VS, Naidu KK, Sarthak S, Hegde AV, Abhinay T. Acute pulmonary thromboembolism: Epidemiology, predictors, and long-term outcome–A single-center experience. Indian Heart J 2017;69(2):160-4.
3. Wu AS, Pezzullo JA, Cronan JJ, Hou DD, Mayo-Smith WW. CT pulmonary angiography :quantification of pulmonary embolus as a predictor of patient outcome-initial experience. Radiology 2004;230(3):831-5.
4. Higazi MM, Fattah RA, Abdelghany EA, Ghany HS. Efficacy of computed tomography pulmonary angiography as non-invasive imaging biomarker for risk stratification of acute

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 06, 2023

pulmonary embolism. J Clin Imaging Sci 2020;10:49.
5. Kumar BP, Rajasekhar D, Vanajakshamma V. Study of clinical, radiological, and echocardiographic features and correlation of Qanadli CT index with RV dysfunction and outcomes in pulmonary embolism. Indian Heart J 2014;66(6):629-34.
6. Varol K, Gumus C, Yucel H, Sezer F, Seker E, Inci MF, et al. Correlation of right ventricular dysfunction on acute pulmonary embolism with pulmonary artery computed tomography obstruction index ratio (PACTOIR) and comparison with echocardiography. Japanese Journal of Radiology 2015;33(6):311-6.
7. Apfaltrer P, Henzler T, Meyer M, Roeger S, Haghi D, Gruettner J, et al. Correlation of CT angiographic pulmonary artery obstruction scores with right ventricular dysfunction and clinical outcome in patients with acute pulmonary embolism. Eur J Radiol 2012;81(10):2867-71.
8. Attia NM, Seifeldein GS, Hasan AA, Hasan A. Evaluation of acute pulmonary embolism by sixty-four slice multi-detector CT angiography: Correlation between obstruction index, right ventricular dysfunction, and clinical presentation. The Egyptian Society of Radiology and Nuclear Medicine 2015;46(1):25-32.
9. Rodrigues B, Correia H, Figueiredo Â, Delgado A, Moreira D, dos Santos LF, et al. Clot burden score in the evaluation of right ventricular dysfunction in acute pulmonary embolism: quantifying the cause and clarifying the consequences. Revista Portuguesa de Cardiologia (English Edition). 2012;31(11):687-95.
10. Guo F, Dai J, Zhang J, Ma Y, Zhu G, Shen J, et al. Individualized 3D printing navigation template for pedicle screw fixation in the upper cervical spine. PloSOne 2017;12(2):e0171509.