

ORIGINAL ARTICLE

Incidental pulmonary embolism in cancer patients undergoing routine CT chest.

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ABSTRACT... Objective: To determine the frequency of incidental pulmonary embolism in cancer patients undergoing routine CT chest. **Study Design:** Cross-Sectional study. **Setting:** Department of Radiology, Shifa International Hospital, Islamabad. **Period:** Eleven months (January to November '25). **Methods:** Included 650 adult cancer patients aged 18–60 years who underwent contrast-enhanced CT chest for diagnostic evaluation, treatment response assessment, or routine surveillance. Patients with suspected or previously diagnosed pulmonary embolism were excluded. Incidental pulmonary embolism was defined as an intraluminal filling defect within the pulmonary arterial vasculature detected on CT performed for indications unrelated to pulmonary embolism. All scans were interpreted by an experienced consultant radiologist. **Results:** Incidental pulmonary embolism was detected in 20 patients, yielding a frequency of 3.1%. Although a higher proportion of pulmonary embolism was observed in patients aged 31–60 years and in males, no statistically significant association was found with age or gender. Similarly, incidental pulmonary embolism showed no significant association with cancer type, disease stage, or treatment modality. **Conclusion:** Incidental pulmonary embolism was identified in a small but clinically important proportion of cancer patients undergoing routine CT chest. Given its potential prognostic implications, careful radiological evaluation and appropriate clinical management of incidental pulmonary embolism are essential to reduce morbidity and mortality in oncology patients.

Key words: Cancer, Computed Tomography, Incidental Pulmonary Embolism, Oncology Imaging, Venous Thromboembolism.

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INTRODUCTION

Venous thromboembolism (VTE) is a known risk factor for both cancer and cancer treatment. Cancer patients have been shown to have a significantly higher risk of VTE than the general population. Nearly twenty percent of all new VTE occurrences in the community are caused by actively progressing cancer. Patients with malignant brain tumors and adenocarcinoma of the ovary, pancreatic, colon, stomach, lung, or prostate have an exceptionally high risk of developing a VTE.¹

In spite of the high frequency, the best care of accidental PE has not been investigated in clinical studies and continues to be a contentious topic of discussion.² Although CT scans have not been performed with a specific PE technique and have poor contrast enhancement, identification of incidental PE has been proven to be accurate up to the segmental and subsegmental arteries.³

The diagnosis of pulmonary embolism is made by accident in patients who are diagnosed with cancer during routine imaging tests. It is not understood what the clinical relevance of distant clots in incidental pulmonary embolism is or what the most effective treatment is for them. The most common types of cancer, according to a survey, were colorectal cancer (21%) and lung cancer (15%). Significant bleeding and recurrent venous thromboembolism occurred in 6% of patients each, and 283 individuals passed away, or 43% of the total. The risk of recurrent venous thromboembolism is considerable in patients with cancer who have experienced an accidental pulmonary embolism, despite the fact that anticoagulant therapy is being administered.⁴

A population-based case control study carried out in the year 2002 was to assess the potential impact of controlling risk factors on the incidence of venous thromboembolism and attributable risks were calculated.

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Apart from multiple other causes for incidental pulmonary embolism established in this study including institutionalization, trauma, congestive heart failure, common neurological diseases with extremity paralysis and varicose veins; it was established that about 18% of incident venous thromboembolism cases were attributable to active malignant neoplasms with or without chemotherapy. Larger population (12%) was attributable to malignant neoplasm without chemotherapy with lesser percent (6%) was found in cases with malignancy with chemotherapy.⁵

It is imperative that the occurrence of symptoms in cancer patients who have experienced accidental PE not be disregarded, as these symptoms may be linked to several significant consequences, including mortality.⁶ The natural development of an unintentional pulmonary embolism is likely to be comparable to that of a symptomatic pulmonary embolism in terms of the chance of recurrent venous thrombotic disease and death, according to research that is based on observations carried out by medical professionals. It is noteworthy to note that there has been an increase in the rate of accidental subsegmental PE along with the increased adoption of more advanced CT techniques. This is something that has occurred. The general assumption is that the treatment for incidental PE is the same as the treatment for symptomatic PE. This is despite the fact that there is a dearth of clinical trials and observational data are limited to cancer-associated incidental PE. This include the selection of the drug class that is the most successful, the utilization of outpatient treatment, and the overall duration of treatment.⁷

The rationale of this study is that as early detection of incidental pulmonary embolism is critical for reduction of morbidity and mortality among the cancer patients, and limited local data is available regarding incidence of incidental pulmonary embolism in cancer patients undergoing routine CT chest. Triage of cancer patients for suspicion of pulmonary embolism along with symptoms of VTE can help in early diagnosis and management of these patients. I have designed this study to determine the burden of incidental pulmonary embolism in cancer patients undergoing routine CT chest.

METHODS

This cross-sectional study was conducted in the Department of Radiology, Shifa International Hospital, Islamabad, over a period of Eleven months (January to November '25) following approval from the CPSP and Institutional Review Board (IRB:485-24, Dated: 05-11-2024). The study aimed to determine the frequency of incidental pulmonary embolism detected on routine contrast-enhanced CT chest examinations performed for indications unrelated to suspected pulmonary embolism. The sample size was calculated using the World Health Organization (WHO) sample size calculator, assuming a 95% confidence level, an absolute precision of 3.65%, and an anticipated prevalence of incidental pulmonary embolism of 7.3%⁸ among cancer patients undergoing routine CT chest imaging, as reported in previous literature. Based on these parameters, a total of 650 patients were required. A non-probability consecutive sampling technique was employed to recruit eligible participants.

Adult patients aged 18 to 60 years with a confirmed diagnosis of malignant carcinoma who were referred for contrast-enhanced CT chest for diagnostic evaluation, treatment response assessment, or routine surveillance were included in the study. Patients with a prior diagnosis of pulmonary embolism, known primary hypercoagulable disorders, or documented deep venous thrombosis within 72 hours prior to the CT examination were excluded. Incidental pulmonary embolism was operationally defined as the radiological detection of pulmonary embolus on contrast-enhanced CT chest performed for indications other than the suspicion, confirmation, or exclusion of pulmonary embolism. Radiologically, pulmonary embolism was identified as an intraluminal filling defect within the pulmonary arterial vasculature. Emboli were categorized as occlusive or non-occlusive, with non-occlusive emboli characterized by a thin peripheral streak of contrast adjacent to the thrombus. Acute emboli typically formed acute angles with the vessel wall, whereas chronic emboli demonstrated obtuse angles. All CT scans were interpreted by an experienced consultant radiologist.

After ethical approval, eligible patients presenting to the radiology department for routine CT chest

examinations were enrolled following written informed consent obtained from the patient or their legal attendant. Demographic and clinical data, including age, gender, type of malignancy, cancer stage, and type of anti-cancer therapy, were recorded using a structured proforma. CT imaging was performed using either a Toshiba Aquilion ONE 320-slice scanner or a Siemens Somatom Definition Edge 128-slice scanner with a slice thickness of 2.0 mm. Intravenous contrast material was administered at a dose of 1.5 mL/kg body weight at an injection rate of 3.0 mL per second. All scans were acquired in the supine position from cranial to caudal direction during end-inspiration. Image interpretation was carried out independently by a consultant radiologist who was blinded to the patients' clinical information to minimize reporting bias. All collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 23. Quantitative variables such as age were expressed as mean $\pm$ standard deviation, while qualitative variables including gender, type and stage of cancer, anti-cancer therapy, and presence of incidental pulmonary embolism were presented as frequencies and percentages.

RESULTS

The characteristics of the 650 cancer patients who participated in the trial when they were first evaluated are presented in Table-I. The average age of the participants was 39.43 years, with a standard deviation of 12.19 years. The majority of the participants, 72.5%, were in the age category of 31–60 years, while 28.5% were in the age group of 18–30 years. There was a little male majority, with 54.9% of the participants being male and 45.1% being female. Regarding cancer type, breast cancer (26.6%) was the most common malignancy, followed by colorectal cancer (20.2%) and lung cancer (17.5%). In terms of disease stage, Stage III cancer constituted the largest proportion (41.1%), followed by Stage II (29.8%) and Stage IV (29.1%). Chemotherapy was the most frequently administered treatment modality (45.5%), whereas 10.9% of patients were under surveillance.

Table-II shows the frequency of incidental pulmonary embolism detected on routine CT chest. Incidental pulmonary embolism was identified in 20 patients

(3.1%), while 96.9% of patients had no evidence of pulmonary embolism.

Table-III demonstrates the association of incidental pulmonary embolism with age group and gender. A higher proportion of pulmonary embolism was observed in patients aged 31–60 years (3.9%) compared to those aged 18–30 years (1.1%); however, this difference did not reach statistical significance ($p = 0.063$). Similarly, although incidental pulmonary embolism was slightly more frequent among males (3.6%) than females (2.4%), no statistically significant association with gender was found ($p = 0.358$).

Table-IV illustrates the relationship between incidental pulmonary embolism and cancer-related factors. The frequency of pulmonary embolism varied modestly across different cancer types, with the highest proportion observed in breast cancer patients (4.0%), but this association was not statistically significant ($p = 0.923$). No significant association was found between pulmonary embolism and cancer stage ($p = 0.994$) or type of anti-cancer therapy ($p = 0.817$). Overall, incidental pulmonary embolism appeared to be evenly distributed across cancer stages and treatment modalities.

DISCUSSION

This cross-sectional study has assessed the burden of incidentally identified pulmonary embolism (iPE) on routine CT chest contrasted examinations of cancer patients at a tertiary care radiology center. The main conclusion was that the rate of incidental PE was 3.1% in patients who had CT chest examination when it was indicated by non-pulmonary embolism. Also, incidental PE showed no significant correlation with age group, gender, type of cancer, cancer stage or treatment modality, but a non-significant tendency towards increased incidence was found in patients aged 31 to 60 years.

The incidence of incidental PE in the current study is in line with the international data that had been reported previously. The abundance of systematic review and meta-analysis studies assessing oncologic staging CT scans reported an incidental prevalence of PE of 3.36 overall with variation based on the type of cancer and scanning protocols.⁹ This

consistency reinforces the external validity of the current study and confirms incidental prevalence of PE as a consistent but not very high finding in heterogeneous oncology populations being subjected to routine CT imaging.

TABLE-I**Baseline characteristics of study participants (N = 650)**

Variable	Category	n	%
Age (years)	Mean $\pm$ SD	39.43	$\pm$ 12.19
Age group	18–30 years	185	28.5
	31–60 years	465	71.5
Gender	Male	357	54.9
	Female	293	45.1
Cancer type	Breast	173	26.6
	Lung	114	17.5
	Colorectal	131	20.2
	Ovarian	74	11.4
	Prostate	61	9.4
	Others	97	14.9
Cancer stage	Stage II	194	29.8
	Stage III	267	41.1
	Stage IV	189	29.1
Therapy type	Chemotherapy	296	45.5
	Radiotherapy	115	17.7
	Combined therapy	168	25.8
	Surveillance	71	10.9

TABLE-II**Frequency of incidental pulmonary embolism**

Outcome	n	%
Positive	20	3.1
Negative	630	96.9
Total	650	100

TABLE-III**Association of incidental pulmonary embolism with age group and gender**

Variable	Category	PE Positive n (%)	PE Negative n (%)	P-Value
Age group	18–30 years	2 (1.1)	183 (98.9)	0.063
	31–60 years	18 (3.9)	447 (96.1)	
Gender	Male	13 (3.6)	344 (96.4)	0.358
	Female	7 (2.4)	286 (97.6)	

TABLE-IV**Association of incidental pulmonary embolism with cancer-related factors**

Variable	Category	PE Positive n (%)	PE Negative n (%)	P-Value
Cancer type	Breast cancer	7 (4.0)	166 (96.0)	0.923
	Lung cancer	4 (3.5)	110 (96.5)	
	Colorectal cancer	4 (3.1)	127 (96.9)	
	Ovarian cancer	2 (2.7)	72 (97.3)	
	Prostate cancer	1 (1.6)	60 (98.4)	
	Others	2 (2.1)	95 (97.9)	
Cancer stage	Stage II	6 (3.1)	188 (96.9)	0.994
	Stage III	8 (3.0)	259 (97.0)	
	Stage IV	6 (3.2)	183 (96.8)	
Therapy type	Chemotherapy	10 (3.4)	286 (96.6)	0.817
	Radiotherapy	2 (1.7)	113 (98.3)	
	Combined therapy	6 (3.6)	162 (96.4)	
	Surveillance / follow-up	2 (2.8)	69 (97.2)	

The differences in the incidence reported in the studies can be explained by the variations in imaging indications, cancer profile, and institutional diagnostic pathways. In a prospective oncology cohort the overall rate of pulmonary embolism was reported to be 4.44% of which 1.3% were incidental and remainder were symptomatic.¹⁰ The higher frequency in such cohorts is probably due to the fact that these were done in patients who are specifically getting CT pulmonary angiography following a clinical suspicion, whereas the current study involved only incidental findings during the routine CT chest examination.

The problem of under-recognition and under-reporting on regular CT scans is an important issue in the interpretation of incidental PE data. The retrospective study of the effectiveness of elective CT in cancer patients discovered that incidental PE could be found in about 4 percent of scans, but only 21 percent were reported in radiology reports, even though many of these were segmental or more

central arteries.¹¹ This study indicates that the actual burden of incidental PE might be underestimated in clinical practice and highlights the significance of systemic image scrutiny and enlightened consciousness of radiologists.

Due to its incidental finding, pulmonary embolism in cancer patients has been established to bear significant prognostic implications. Population-based cohort studies that incorporated immortal time bias showed that incidental PE patients had much higher long-term mortality with an adjusted hazard ratio of 2.26 than cancer patients without PE.¹² Notably, the cause of death in the patients was mostly due to the underlying malignancy features that comprised of metastatic disease.

Its clinical significance is further demonstrated by the risk that repeat venous thromboembolism (VTE) may occur in untreated incidental PE. In a matched cohort study of unreported and untreated incidental PE in cancer patients, there was a significant pattern of recurrence risk increase by embolic burden (one-year risk of recurrent VTE of 52-72 events per 100 person-years in patients with multiple subsegmental or more proximal emboli) and the risk could not be placed on isolated single subsegmental PE.¹³

The results of the current investigation showed that there is no statistically significant correlation between the incidental PE and the demographic factors, cancer type, cancer stage, or treatment modality. Recent studies have also indicated similar results where incidental PE was equally distributed among clinical subgroups with no statistically significant association; this could be due to few incidents of PE limiting statistical power, non-specific grouping of malignancies and referral bias since patients with clinical suspicion of PE are most likely to be subjected to dedicated CT pulmonary angiography and not the current CT chest.¹⁴

The findings of the present study indicated that no statistically significant correlation exists between the incidental PE and the demographic characteristics, cancer type, cancer stage and treatment modality. Similar results were also reported in the recent studies in which incidental PE was equally distributed among clinical subgroups with no statistically

significant relationship; this might be attributed to limited number of incident PE which restricts the power of the test and non-specific grouping of malignancies⁹ and referral bias since patients with clinical suspicion of PE are most likely to receive dedicated CT pulmonary angiography and not the present CT chest.

Clinically and radiologically, there is an emerging evidence that incidental PE in cancer patients cannot be treated differently to symptomatic PE. Similar perioperative risks of repeated occurrence and death have been demonstrated in observational studies and expert reviews of consensus, justifying the use of anticoagulation, effective in most situations, and considered after an individual evaluation of the risk of bleeding and the overall prognosis.¹⁵

The strengths of this research are that it has a large sample size, the contemporary multidetector CT scanners were used, the imaging protocols were standardized, and the interpretation was performed by the experienced consultant radiologists. Nevertheless, there are a number of limitations that ought to be taken into consideration. The cross-sectional design did not allow evaluating the outcomes in terms of recurrence, bleeding, and mortality. Also, central venous catheterization, immobilization, thromboprophylaxis use, and metastatic burden were not examined in detail as risk factors of thrombosis. Routine CT chest as opposed to PE-specific protocols can also have decreased sensitivity to very distal emboli, as reported in previous studies.¹¹

In conclusion, incidental PE was found in 3.1% of cancer patients with a regular contrast-enhanced CT chest examination which is also consistent with the world literature, as associated with a high risk of further VTE in the untreated cancer patient,¹ thirteen, and increased mortality, eleven. The standardized radiological reporting and multidisciplinary care pathways implementation is critical to maximize the results in this high-risk group.

CONCLUSION

Incidental pulmonary embolism was detected in 3.1% of cancer patients undergoing routine contrast-enhanced CT chest examinations performed

for indications other than suspected pulmonary embolism. Although no statistically significant associations were observed with age, gender, cancer type, disease stage, or treatment modality, the presence of incidental pulmonary embolism remains clinically important due to its established association with increased risk of recurrent venous thromboembolism and adverse outcomes in oncology populations.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

1	Namrah Khalid: Data collection, writing.
2	Rashid Nazir: Review of manuscript.
3	Amna Mehboob: Literature review.
4	Ranam Akhtar: Data analysis.
5	Nasir Khan: Data entry.
6	Tariq Mahmood: Paper writing.