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Indian Journal of Forensic and Community Medicine

Journal homepage: https://www.ijfcm.org/

Case Report

Death due to early pulmonary thromboembolism following tibial fracture: A case report

T. Mohit Kumar Moses[1], Shipra Tadi[2], Bharathi Devi Kasireddi[3], Mahesh Mandala[4], Nishanth V.S[5]*, Kattamreddy Ananth Rupesh[1]

[1]*Dept. of Forensic Medicine and Toxicology, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India*
[2]*Dept. of Orthopaedics, Osmania Medical College, Hyderabad, Telangana, India*
[3]*Andhra Medical College, Visakhapatnam, Andhra Pradesh, India*
[4]*Dept. of Forensic Medicine and Toxicology, Siddhartha Medical College, Vijayawada, Andhra Pradesh, India*
[5]*Dept. of Forensic Medicine and Toxicology, Government Medical College, Nizamabad, Telangana, India*

ARTICLE INFO

Article history:
Received 10-03-2024
Accepted 29-03-2024
Available online 04-04-2024

Keywords:
Long bone fracture
Early pulmonary thromboembolism
Ee novo thrombi

ABSTRACT

Pulmonary Thrombo Embolism (PTE) is primarily attributed to venous thromboembolism, resulting in the obstruction of pulmonary arteries by a thrombus that impedes blood flow to the lungs. The thrombus typically gets lodged at the bifurcation of the main pulmonary artery or the lobar branches, leading to hemodynamic compromise. While the origin of the thrombus is commonly traced back to the lower extremities (Deep Vein Thrombosis, DVT), in rare instances, it may arise from the pelvis, renal veins, upper extremity veins, or right side of the heart. Various factors can contribute to the development of deep vein thrombosis, but in the context of long bone fractures, it is predominantly associated with prolonged immobilization. The typical time frame for DVT to manifest after the injury is 7 to 10 days. However, there have been infrequent cases where PTE has developed within 72 hours of the injury. Several theories have been proposed to elucidate the early onset of PTE in such cases.

This report presents a case of early pulmonary thromboembolism in a tibial fracture, as observed during the autopsy examination of a 22-year-old male who succumbed to injuries sustained in a road traffic accident within 6 hours of the incident. Subsequent histopathological analysis following the autopsy revealed the presence of a thrombus in the pulmonary artery.

1. Introduction

Pulmonary thromboembolism (PTE) is defined as the occlusion of pulmonary vessels due to a thrombus. Deep Venous Thrombosis (DVT) has been commonly implicated as an etiology for PTE. DVT results from thrombus formation in the deep veins of the leg after trauma when the patient remains bedridden for days. This is primarily due to the stasis of blood flow in the leg veins, one of the three reasons for the genesis of thromboembolism according to Virchow. Virchow's triad consists of venous stasis, endothelial injury, and hypercoagulability, which are the three key factors contributing to the development of thromboembolism, including pulmonary thromboembolism.[1] Through circulation, emboli travel to the right side of the heart and from there on to pulmonary vessels. Such emboli may get deposited in the pulmonary arteries, leading to pulmonary thromboembolism. A PTE poses a serious threat to life, and it is a consequence of venous thromboembolism rather than a separate illness.

The classic presentation of PTE is the abrupt onset of pleuritic-type chest pain, shortness of breath, and

* *Corresponding author*.
E-mail address: nishanthsenthilvel@gmail.com (Nishanth V.S).

https://doi.org/10.18231/j.ijfcm.2024.008

hypoxia, and most patients have no obvious symptoms at presentation. Massive pulmonary thromboembolism is a condition in which both the pulmonary arteries are involved or when an embolism results in a severe hemodynamic compromise. After a long bone fracture, pulmonary thromboembolism develops within a week and in some rare cases within 72 hours. The alteration of coagulation-anticoagulation homeostasis during trauma is one of the predisposing factors for thromboembolism. Therefore, as a matter of routine in all severe trauma conditions, patients should receive prophylactic anticoagulant therapy and be evaluated for post-traumatic pulmonary thromboembolism. The development of early post-traumatic pulmonary thromboembolism depends on patients' factors and also the extent of long bone fracture. In the reported case, a pulmonary embolism developed in less than 6 hours following trauma, which is a rare entity.

2. Case Report

A 22-year-old male resident of Visakhapatnam was involved in an accident when he was hit by a lorry. He presented at the emergency department of KGH 1.5 hours after the incident with stable vitals, but he complained of pain in his left lower limb. On examination, a visible deformity of the left leg with a limited range of motion was noted. An emergency X-ray confirmed fractures at both ends of the left tibia. To stabilize the leg, an above-knee cast was applied, and he was advised to be admitted for further investigations and management. However, 5 hours after the incident, he left the hospital against medical advice. Approximately 1 hour later, he experienced a sudden onset of breathlessness and was readmitted to the hospital. Despite resuscitative efforts, he was declared brought dead. A post-mortem examination was conducted on the same day to further investigate the case.

During the external examination, several abrasions were observed on the body. These abrasions were present on the outer aspect of the right arm, outer aspect of the left arm, left elbow, back of the left forearm, right renal angle, front of the thigh, and both knees. Additionally, a closed fracture of the left tibia was identified at both the upper and lower ends. All the injuries appeared to be recent and antemortem in nature. Moving on to the internal examination, congestion was observed in all visceral organs. The lungs were notably heavy and congested. To further investigate, the lungs were preserved for histopathological examination. Histopathological examination of the lung revealed the presence of a thrombus within the pulmonary vessels, as shown in Figures 1 and 2. Additionally, the alveoli showed occasional lymphocytes, and the bronchus exhibited mild inflammatory infiltrates around the bronchial wall. Based on these findings, the cause of death was determined to be pulmonary embolism, secondary to the tibial fracture.

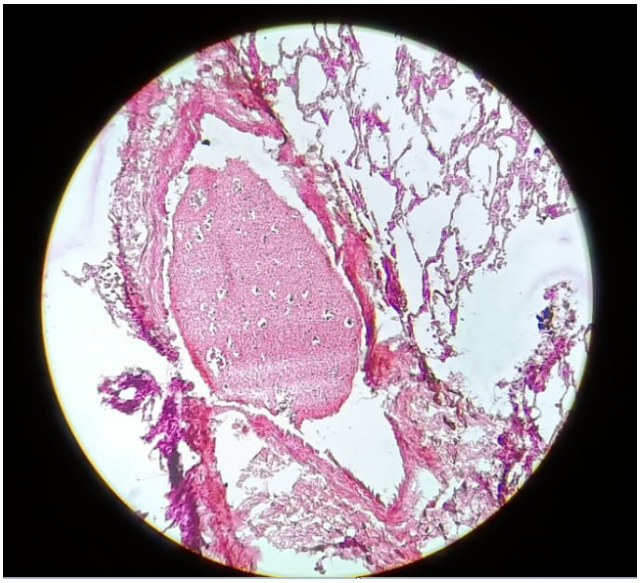

Figure 1: High power magnification

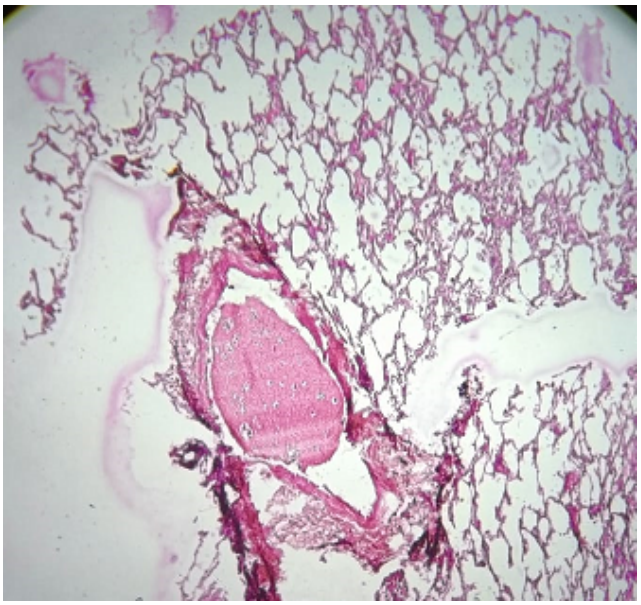

Figure 2: Low power maginification

Figures 1 and 2 are photomicrographs showing thromboembolism in a large pulmonary artery occluding most of the lumen. Internal elastic lamina is degenerated and disrupted at one end.

3. Discussion

A fracture is an abnormal disruption in the continuity of a bone. The long bones in the human body include the humerus, radius, ulna, femur, tibia, and fibula. Among these, the tibia is the most commonly fractured long bone, accounting for approximately 6.6% of all fractures. Long

bone fractures can give rise to various complications, including fat embolism, shock, compartment syndrome, deep vein thrombosis (DVT), pulmonary thromboembolism (PTE), disseminated intravascular coagulation (DIC), impaired wound healing, coagulopathy, and infection. Among these complications, PTE stands out as a significant cause of mortality in individuals with long bone fractures.

In general, 99% of complications that arise out of long bone fractures are manageable whereas in 1% of cases, the complications can lead to death. There are five categories of causes of death associated with bone fractures: cardiovascular causes, infection, respiratory causes, malignancy, and others. Cardiovascular causes include myocardial infarction, heart failure, and cerebrovascular accidents. Infection encompasses conditions like sepsis and pneumonia. Respiratory causes include pulmonary thromboembolism and respiratory failure. Other causes involve renal failure and multiple organ failure. The mortality rate in cases of bone fractures is influenced by factors such as gender, smoking habits, body mass index (BMI), congestive heart failure, dementia, moderate to severe renal disease, and history of a malignant tumor.

The incidence of PTE among trauma patients varies widely, ranging from 0.35% to 24%.[2–5] Differences in population characteristics, injury severity, and screening protocols contribute to the variability in reported incidences.[3] The computed tomography pulmonary angiogram (CTPA) is considered the best investigation modality with high predictive value for diagnosing pulmonary thromboembolism (PTE), providing detailed visualization of the pulmonary arteries. It is the preferred choice due to its superior diagnostic accuracy and ability to precisely determine the location and extent of the clot, aiding in treatment decisions and risk stratification of patients with suspected PTE. In the past, screening for asymptomatic pulmonary thromboembolism was impractical. However, recent studies, such as the one by Schultz,[6] have shown a higher incidence of occult PTE than previously reported. Schultz documented a 24% incidence of asymptomatic PTE in 90 moderately-to-severely injured trauma patients using systematic contrast-enhanced helical computed tomography (CT) scanning.[5,6] The advancement in CT scanning technology, particularly the use of multi-detector scanners, has improved the accuracy of PTE detection.[6] Other investigations carried out for workup of a case of pulmonary thromboembolism include chest X-ray, ECG, arterial blood gases, 2-level PE Wells score, bedside echocardiography, Color Doppler ultrasound of the leg veins, D-dimer test, and serum troponin I. The measurement of Tissue Plasminogen Activator Resistance (tPA) can help identify early signs of post-traumatic pulmonary thromboembolism (PTE). Fibrinolysis shutdown and tPA resistance are additional factors that increase the risk of early PTE. Early detection of a hypercoagulable state through tPA resistance within 12 hours of admission can be crucial, as it presents an opportunity for intervention and management to reduce the risk of PTE. The management of pulmonary embolism involves anticoagulation therapy, thrombolytic and surgical therapy, and the use of cavalry filters. Prophylactic treatment of PTE includes the use of anticoagulants such as heparin, LMW heparins, warfarin, and apixaban.[7]

As already stated, long bone fractures are associated with an increased risk of early pulmonary thromboembolism (PTE).[7–10] Conventionally, it was believed that PTE occurs most commonly between day 5 and day 7 following the traumatic event, with rare occurrences before day 4.[11] This understanding stemmed from the traditional teaching that post-traumatic PTE originates from deep venous thrombosis (DVT) in the lower extremities and pelvis.[7–9,11,12] Stasis considered the primary factor in DVT formation and subsequent PTE in trauma patients, led to the notion that these events take place after 5 to 7 days following the injury[7–9,11,12]. However, recent studies have challenged this notion. Darabadi[10] found that 40.4% of trauma patients with PTE experienced early PTE. A significant number of post-traumatic PTE cases occur very early, even immediately after the injury.[7–11,13] Reviewing the literature, lower limb fractures are noticed to be associated with early PTE.[7–10,14,15]

Several risk factors influence the timing of post-traumatic PTE, including advanced age,[4,10,16] obesity,[17–19] severe injury characteristics, compromised hemodynamic state,[14] sepsis,[20] hypoxemia,[21,22] initial use of transfusions,[8] surgical measures within 72 hours[23] and use of tranexamic acid (TXA) in head trauma.[24] Pulmonary thromboembolism was identified as the sudden cause of death in this case, with histopathological examination revealing thrombi in pulmonary arterioles. Post-traumatic pulmonary thromboembolism is a life-threatening condition that typically develops within a week or, in some cases, within 72 hours after a long bone fracture. However, in this particular case, pulmonary thromboembolism occurred within 6 hours of the trauma, which is considered a rare scenario. Early pulmonary thromboembolism is associated with risk factors such as a history of surgery, hospitalization, pregnancy, cancer, and a family history of blood clots (Factor V Leiden). The occurrence of early post-traumatic pulmonary embolism depends on factors related to the fracture location and patient characteristics.

Various pathophysiological mechanisms are involved in the early onset of pulmonary thromboembolism (PTE). These mechanisms include undiagnosed congenital or acquired prothrombotic conditions, hypercoagulable states within the first four days after trauma, the presence of pulmonary clots, the independent risk factor of long bone fracture, and molecular phenomena associated with the fracture that lead to the formation of de novo thrombi in the

pulmonary circulation. These factors collectively contribute to the increased risk of early PTE development in patients with long bone fractures.

The adrenergic response following trauma may also contribute to early pulmonary thromboembolism by causing vascular endothelial inflammation and the synthesis of circulating adhesion molecules, leading to thrombosis and rapid occlusion. Risk factors for pulmonary thromboembolism include obesity, advanced age, sepsis, acute renal failure, and congenital prothrombotic conditions. Early pulmonary thromboembolism is more commonly observed in cases with a higher rate of lower extremity fractures and severe extremity trauma.[25–32]

In summary, the pathophysiology of PTE involves several key elements. The lethal triad of death, consisting of hypothermia, acidosis, and coagulopathy, contributes to a prothrombotic state. Systemic inflammatory response syndrome (SIRS) and compensatory anti-inflammatory response syndrome (CARS) can lead to endothelial dysfunction and promote thrombosis. Stress mechanisms induce hypercoagulability by increasing platelet activation and aggregation, while the primary hit mechanism initiates clot formation, and the secondary hit mechanism worsens the prothrombotic state. Disseminated intravascular coagulation (DIC) plays a role, with widespread coagulation activation leading to microthrombi formation and subsequent PTE.

4. Conclusion

In conclusion, the occurrence of early pulmonary thromboembolism (PTE) within 6 hours after bone trauma is a rare occurrence, with the underlying cause still unclear. However, this case suggests that the development of early PTE may be attributed to a hypercoagulable state induced by the multi-site fracture, potentially serving as a physiological response to counteract excessive blood loss. Nonetheless, this disrupted coagulation-anticoagulation homeostasis proved detrimental. Therefore, thorough screening for pulmonary thromboembolism should be implemented in patients with long bone fractures, and proactive measures to mitigate the risk of PTE should be employed.

5. Source of Funding

None.

6. Conflicts of Interest

None to declare.

7. Ethics Committee Approval

Taken.

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Author biography

T. Mohit Kumar Moses, Assistant Professor https://orcid.org/0000-0003-4524-8387

Shipra Tadi, Senior Resident https://orcid.org/0009-0002-2753-2333

Bharathi Devi Kasireddi, MBBS Student https://orcid.org/0009-0009-1477-2961

Mahesh Mandala, Assistant Professor https://orcid.org/0009-0004-9694-7270

Nishanth V.S, 3rd Year Postgraduate https://orcid.org/0009-0000-4247-5619

Kattamreddy Ananth Rupesh, Assistant Professor https://orcid.org/0000-0003-1525-3740

Cite this article: Moses TMK, Tadi S, Kasireddi BD, Mandala M, Nishanth V.S, Rupesh KA. Death due to early pulmonary thromboembolism following tibial fracture: A case report. *Indian J Forensic Community Med* 2024;11(1):30-34.