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Case Report

A rare incidence of acute pulmonary embolism following surgical fixation of bilateral upper extremity fractures - A case report

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ABSTRACT

Case: A 52-year-old male fell from his bike and sustained fractures of the right proximal humerus and the left distal radius, both of which were fixed in a single sitting a day after the injury. On postoperative day four, the patient developed features suggestive of acute pulmonary embolism. *Conclusion:* Reports of acute pulmonary embolism developing after surgical fixation of bilateral upper extremity fractures are rare. A high index of suspicion especially in patients with predisposing risk factors is essential to identify the signs of a thromboembolic event and initiate appropriate intervention.

Introduction

While there are several accounts of thromboembolic events in association with lower extremity fractures, reports of pulmonary embolism following upper extremity fractures are scarce. There are a few reports of thromboembolic complications developing after elective shoulder arthroscopy and shoulder replacement surgery. There is only one report in the literature describing pulmonary thromboembolism occurring following surgical fixation of a distal radius fracture [1]. In this report, we present a rare incidence of acute pulmonary embolism following surgical fixation of bilateral upper extremity fractures.

Case

A 52-year-old male presented with a history of a fall from his bike. He had sustained injuries to the right shoulder and the left wrist. After the initial evaluation and the assessment of the radiographs, he was found to have a contusion over the right shoulder and closed fractures of the right proximal humerus and the left distal radius with intact neurovascular status (Fig. 1). There were no systemic injuries. The patient was a known asthmatic and was categorized as obese (body mass index/BMI of 32.3) with signs of obstructive sleep apnoea. Following routine cardiological evaluation, a day after the injury, the right proximal humerus and the left distal radius fractures were fixed with plating. The surgeries were performed one after the other under nerve blocks and the total duration of both the surgeries was 3 h. A tourniquet was applied during the fixation of the left distal radius fracture and it was inflated for a total period of 35 min. There were no complications intraoperatively. Following the surgery, the patient was encouraged to walk with the right upper limb immobilized in an arm sling and the left in an above-elbow slab. The patient was comfortable and was able to walk around

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in the immediate postoperative period. The size of the contusion over the right shoulder was reducing and the operative wounds were healing well (Fig. 2). However, on postoperative day four, the patient suddenly developed difficulty in breathing. His room air oxygen saturation dropped to 78 % with a respiratory rate of 28/min. He was suspected to have an acute exacerbation of bronchial asthma and was administered an injection of Hydrocortisone 1000 mg and was started on Budesonide and Salbutamol nebulization.

Immediate electrocardiogram and echocardiogram scans were performed and troponin I, serum homocysteine, Protein C, Protein S, B2-microglobulin, anti-lupus anticoagulant and anti-cardiolipin antibody levels were checked to rule out cardiac pathology. The electrocardiogram and echocardiogram scans showed dilatation of the right atrium and ventricle. While the troponin I level was elevated, all other biomarker levels were within the normal range (Table 1). A CT pulmonary angiography was performed and it revealed an acute thrombus occluding the right pulmonary arteries, with further involvement of the bilateral upper, mid & lower lobar arteries. There was complete occlusion of the posterior basal and lateral basal segmental and subsegmental branches bilaterally suggesting acute pulmonary embolism (Fig. 3). However, venous Doppler scans of the upper and lower limbs showed no signs of deep vein thrombosis (DVT). The patient was then started on 1 mg/kg of subcutaneous Enoxaparin injection, twice a day. After five days, the patient was discharged with an oral antithrombotic, Apixaban 5 mg, twice a day for 3 months. The patient was evaluated at regular follow-up visits every 2 months, for up to one year. He did not experience any new or recurrent thromboembolic events and the fractures had united well.

Discussion

Venous thromboembolism (VTE), encompassing the conditions of deep vein thrombosis (DVT) and pulmonary embolism (PE), is the third most frequent acute cardiovascular syndrome worldwide, next only to myocardial infarction and stroke [2]. The incidence of VTE is not uncommon following orthopaedic surgery, with reported rates as high as 10.7% [3]. The majority of the studies, however, are based on lower extremity injuries, specifically hip and pelvi-acetabular fractures. There are a few reports of thromboembolic complications developing after elective shoulder arthroscopy and shoulder replacement surgery. However, there is no clarity in the literature about the risk of PE after the surgical fixation of upper extremity fractures, nor are there any guidelines regarding its prevention and management [4,5].

It has been established that Virchow's triad of haemostasis, altered blood vessel walls and abnormal blood constituents predisposes to thrombus formation. Keeping this in mind, when we look at the causation of VTE, some of the proven risk factors include diabetes, prolonged immobilization, cancer and hypertension. Other risk factors that have been described specifically for DVT include pregnancy, obesity, and oestrogen supplementation [6–8]. According to Zhang et al., a higher body mass index (BMI), older age and a longer operative duration increased the risk of VTE in patients following shoulder arthroplasty [9]. Paul et al. studied the association of obesity with VTE and found that in obese patients, the relative risk of DVT was 2.50 while the relative risk of PE was 2.21 [10]. The traumatic event in itself has also been postulated to be a risk factor due to the pathophysiological changes in the coagulation pathways

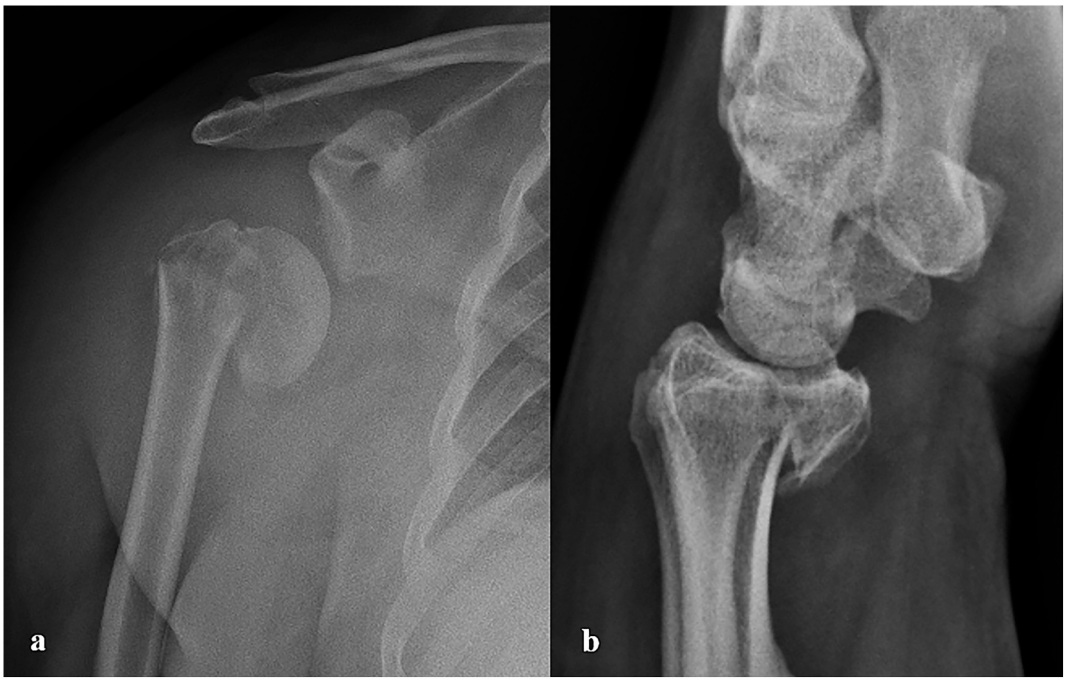

Fig. 1. Closed fractures of a) the right proximal humerus.
b) The left distal radius.

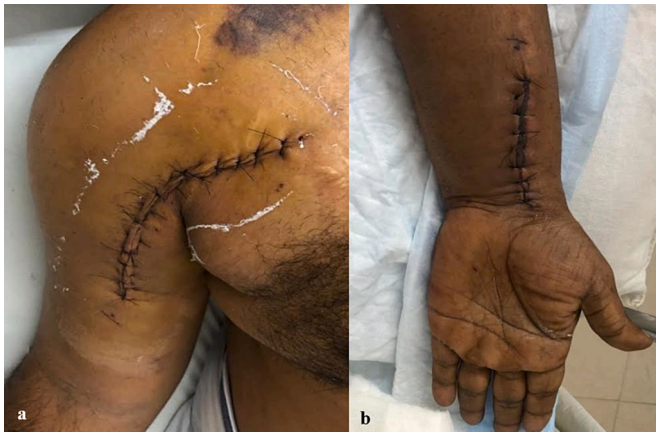

Fig. 2. a) Contused area over the right shoulder and satisfactory wound healing in the immediate postoperative period.
b) Satisfactory wound healing in the immediate postoperative period - the left wrist.

Table 1
Blood investigation reports : Only the level of Troponin I was elevated above the normal level. All other biomarkers for cardiac pathology, hypercoagulability and antiphospholipid syndrome were within normal levels.

Serum lactate	3.62 mmol/L
White blood count (WBC)	6300 cells/cu mm
C-reactive protein (CRP)	28.10 mg/L
N terminal pro B-type natriuretic peptide (NT proBNP)	160 pg/mL
Procalcitonin	0.05 ng/mL
Troponin I (TROP I)	**266 ng/L**
Prothrombin time (PT)	14 s
International normalized ratio (INR)	1
Activated partial thromboplastin time (aPTT)	29.3 s
Anti cardiolipin antibody (IgG)	0.6 gPL U/mL
Anti cardiolipin antibody (IgM)	1.3 mPL U/mL
Beta 2 microglobulin	2194 µg/L
Homocysteine	15.74 umol/L
Lupus anticoagulant 1 (LA1)	38.1 s
Lupus anticoagulant 2 (LA2)	26.9 s
LA1/LA2 ratio	1.41
Protein-C activity	108 %
Free Protein-S	99 %

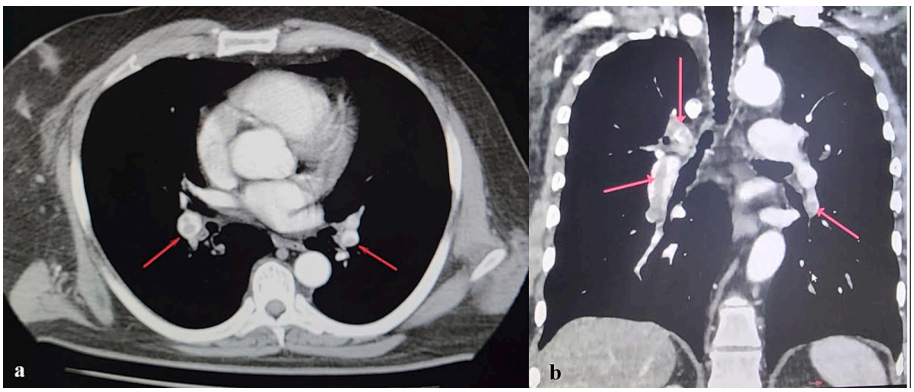

Fig. 3. CT pulmonary angiography images.
a) Axial view with the red arrows pointing to blocks in the bilateral segmental pulmonary arteries.
b) Sagittal view with the red arrows pointing to blocks in the upper, mid & lower lobar arteries.

and the systemic inflammatory response from the tissue injury [11]. This phenomenon of "trauma-induced coagulopathy" involves the release of proinflammatory cytokines and procoagulant microparticles creating a hypercoagulable state. Additionally, the localized swelling that develops at the surgical site predisposes to venous stasis [12]. These described risk factors ring true for the patient in this report. He was found to have a high BMI and was categorized as obese. The contusion over the right shoulder was a predisposing factor for venous stasis. The bilateral upper extremity fractures might have triggered trauma-induced coagulopathy. Both the fractures were fixed in the same sitting under bilateral nerve blocks which resulted in a longer operative duration.

Kucher et al. in their study about DVT in upper extremities stated that it could be attributed to primary causes like venous thoracic outlet syndrome, Paget-Schroetter syndrome and idiopathic causes or secondary causes like the presence of an indwelling device (for example, a central venous catheter), cancer and surgery involving the upper extremities [13]. The patient in this case report developed PE following surgery for bilateral upper extremity fractures. However, the Doppler scans of both the upper and the lower extremities revealed no signs of DVT. There are very few studies about the incidence of PE in association with upper extremity fractures. Gur V et al. in their study found the incidence of PE following upper extremity trauma to be 0.64% [14]. Another study by Petrigliano et al. assessed patients who were treated with open reduction and fixation for proximal humerus fractures and found that there was an increased risk of PE associated with male gender and age $\geq$ 75 years [15].

While knowledge of the predisposing factors is important to determine the clinical risk of PE, some patients with PE have been found to have no identifiable risk factors [16]. White et al. found that in 40 % of patients with PE, there were no predisposing factors [17]. In a study by Wendelboe et al., 30 % of patients with PE were associated with minor or no risk factors and were classified as "unprovoked" [18]. Due to the rarity of this phenomenon, the etiology and the complications are poorly understood and the majority of information has been obtained from case reports or studies with small sample sizes. The clinical diagnosis in the scenario of unprovoked PE is a dilemma since the symptoms of PE such as dyspnea, cough, chest pain and haemoptysis are non-specific [19].

Certain biomarkers have been postulated to play a role in the assessment of PE risk. Markers like protein C, protein S and homocysteine can help identify whether there is hypercoagulability. Kaeberich et al. studied the role of cardiac troponin and found that when interpreted in combination with clinical and imaging findings, they may be able to predict an elevated PE risk [20]. Acute PE leads to right ventricle pressure overload in the heart. The resultant increased myocardial stretch leads to the release of B-type natriuretic peptide (BNP) and N-terminal (NT)-proBNP. Coutance et al. found that while elevated BNP/NTproBNP concentrations had low specificity and positive predictive value, reduced levels of BNP/NT-proBNP helped exclude an unfavourable clinical outcome [21]. In this patient, along with symptoms of dyspnoea, the cardiac troponin I level was increased while the levels of protein C, protein S, homocysteine and NT-proBNP were within the normal range. Antiphospholipid syndrome is often present in patients with unprovoked PE and has implications on the duration of anticoagulation. In this patient, however, the markers for antiphospholipid syndrome such as anticardiolipin antibodies, lupus anticoagulant and beta 2 microglobulin were negative [22].

For most cases of PE without haemodynamic compromise, parenteral or oral anticoagulation without reperfusion techniques is the recommended treatment [23]. However, there are no studies on PE prophylaxis specifically for patients with upper extremity fractures. The patient in this case report was immediately started on injection Enoxaparin and after 5 days was discharged with an oral anticoagulant, Apixaban 5 mg, twice a day for 3 months. Given the paucity in the literature, there is an immediate need for multi-centre multi-cohort studies on the association of DVT and PE with upper extremity fractures to arrive at an evidence-based protocol for prophylaxis and management.

Conclusion

Although the occurrence of VTE in association with lower extremity fractures has been described in the literature, reports of PE developing after fixation of bilateral upper extremity fractures are rare. Timely diagnosis and intervention ensured the patient in this report recovered uneventfully. A high index of suspicion following fixation of bilateral upper extremity fractures, especially in patients who have predisposing risk factors is essential to identify the signs of a thromboembolic event and initiate timely and appropriate intervention.

CRediT authorship contribution statement

Mohamed Zackariya: Conceptualization, Data curation, Formal analysis, Investigation, Supervision. **Sanjana Nandakumar:** Conceptualization, Data curation, Formal analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing. **Dheenadhayalan Jayaramaraju:** Project administration, Resources, Supervision, Validation. **Devendra Agraharam:** Project administration, Supervision, Validation, Visualization. **Rajasekaran Shanmuganathan:** Project administration, Resources, Software, Supervision, Validation, Visualization.

Declaration of competing interest

All the authors of the submission titled "A rare incidence of acute pulmonary embolism following surgical fixation of bilateral upper extremity fractures - A case report" certify that they have no conflicts of interest.

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