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Precautionary strategy for high-risk airway bleeding cases during robotic-assisted bronchoscopy

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Abstract

Bronchoscopy in thrombocytopenic patients remains a controversial topic as traditionally varying platelet thresholds have been stablished as "safe," ranging from 20,000 to 50,000. A lower threshold may be safe for a routine airway inspection with bronchoalveolar lavage but will be far from safe for more invasive interventions such as needle biopsy, transbronchial biopsy, or cryo-biopsy. Currently, a minimal platelet threshold during robotic-assisted bronchoscopy (RAB) has not been established. In addition, the absolute platelet number does not guarantee appropriate platelet function. The literature regarding the safety of bronchoscopy and its bleeding risk, considering broader and more functional tests such as thromboelastography (TEG), is also lacking. We present our RAB approach to safely sample lung nodules in a patient with thrombocytopenia. Our precautionary strategy for high-risk bleeding cases during RAB utilizing TEG and parallel flexible bronchoscopy with segmental balloon occlusion may be an appropriate technique to minimize bleeding risk.

Introduction

Bronchoscopy in thrombocytopenic patients remains a controversial topic. Different platelet thresholds have been stablished as "safe," ranging from 20,000 to 50,000 [1]. A significant contributor to the perpetuation of this dilemma is the generalization of the term "bronchoscopy." A threshold of 20,000, or even lower, may be safe for a routine airway inspection with bronchoalveolar lavage; however, the same threshold may be far from safe for more invasive interventions such as needle biopsy, transbronchial biopsy, or cryo-biopsy [2,3]. An airway haemorrhage of as little as 150 mL could be lethal turning into asphyxia [4]. Currently, a minimal platelet threshold during robotic-assisted bronchoscopy (RAB) has not been established. In addition, the absolute platelet number does not guarantee their appropriate platelet function. The literature regarding the safety of bronchoscopy and its bleeding risk, considering broader and more functional tests such as thromboelastography (TEG), is also lacking. TEGs have not been validated for bronchoscopic interventions; however, they have been validated to assess haemostasis in patients with hepatic compromise and post-cardiopulmonary bypass coagulopathies. We present our RAB approach to minimize the risk of bleeding during the sampling of a lung nodule in a patient with thrombocytopenia.

Case Report

A 37-year-old current smoker man (15 pack/year history) with a past medical history of advanced high-grade B-cell lymphoma presented for evaluation. He had received chemotherapy with a reduced intensity conditioning (RIC) with fludarabine and busulfan flowed by allogenic haematopoietic cell transplantation (HCT) complicated with graft-versus-host-disease with skin and hepatic involvement. He presented to the hospital with lethargy and altered mental status 180 days post HCT. Magnetic resonance imaging (MRI) of the brain was pertinent for

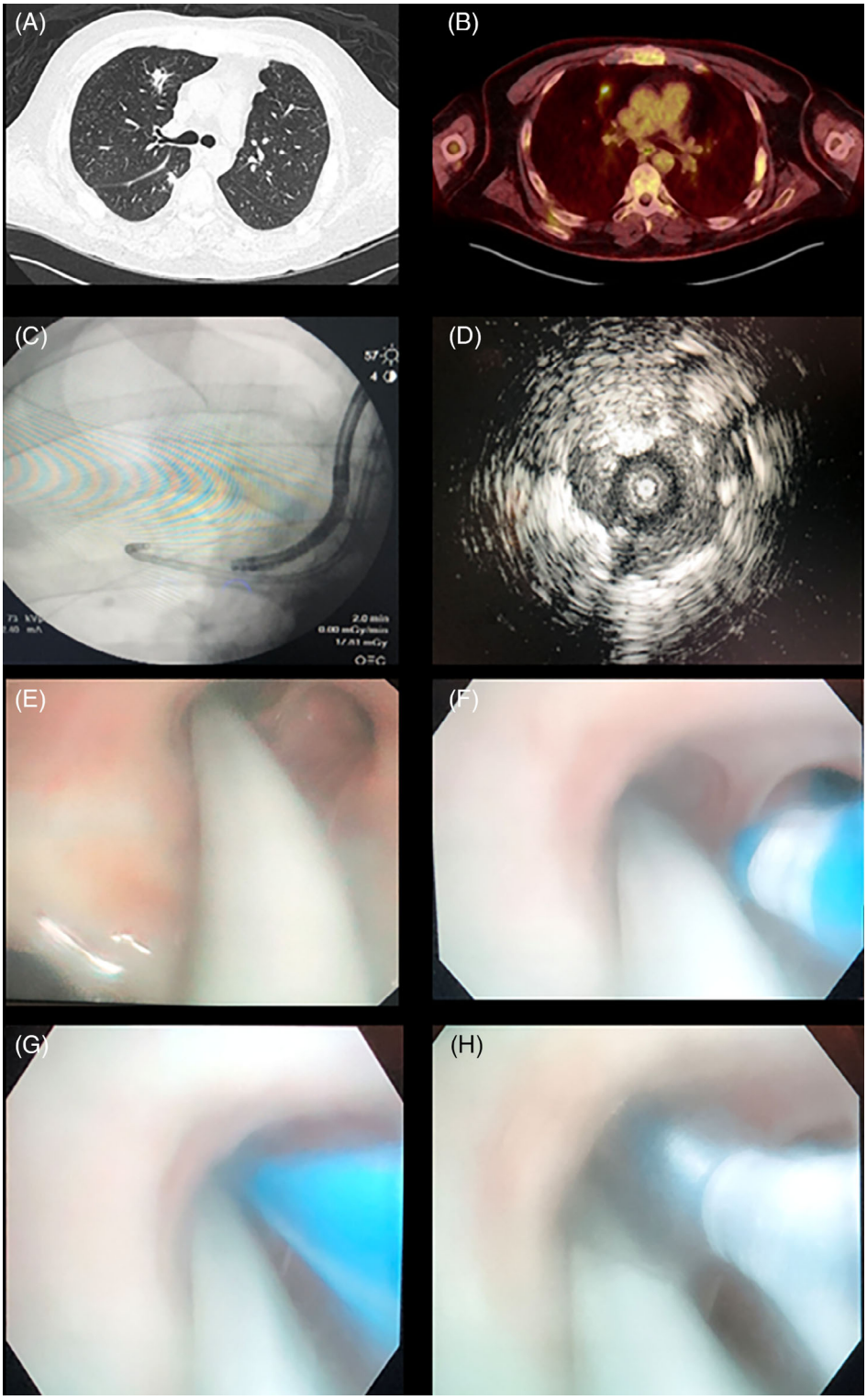

Figure 1. (A) Chest computed tomography (CT) showing a 17-mm nodule in the right upper lobe. (B) Positron emission tomography (PET) CT showing standardized uptake values (SUV) uptake in the right upper lobe with an SUV of 4.4. (C) Fluoroscopy showing simultaneous robotic-assisted bronchoscopy (RAB) and flexible bronchoscopic approach. (D) Concentric radial endobronchial ultrasound (EBUS) signal achieved through RAB. (E) Robotic arm going into RB3 segment. (F, G) Fogarty catheter directed into the RB3 segment guided through flexible bronchoscopy. (H) Fogarty balloon inflated to limit airway bleeding.

lesion of the splenium of the corpus callosum extending into the left occipital lobe as well as medial biparietal regions with restricted diffusion, T2 hyperintensity, and intralesional haemorrhage. These findings were highly concerning for lymphoma progression versus opportunistic infection. Computed tomography (CT) of the chest and positron emission tomography (PET) CT showed multiple new right-sided well-defined spiculated pulmonary

nodules, the largest one was 17 mm with their standardized uptake values ranging from 4.4 to 5.4. No mediastinal or hilar lymphadenopathy was noted. His overall care had been complicated by multifactorial pancytopenia, difficulties achieving human leukocyte antigen (HLA)/cross-matched compatible transfusions, and transfusion-resistant thrombocytopenia. The patient received platelet transfusions on the day of bronchoscopy, with a subsequent limited ability to increase his platelet numbers to more than 37×10^9/L. Desmopressin was given to enhance platelet function and TEG prior to the procedure showed: *R* time 6.3, *K* time 1.5, max. amplitude 59.2, degree angle 68.1, and lysis 30 time 0.3.

RAB was performed with the goal of sampling one of the pulmonary nodules and further establish their aetiology. Airway inspection was within normal limits. The robotic bronchoscope was driven into the anterior segment of the right upper lobe (RB3) reaching the virtual target lesion. A concentric radial endobronchial ultrasound signal of the lesion was confirmed (Fig. 1). Prior to needle biopsies, and in order to minimize the risk of a significant airway bleeding (SAB), a standard bronchoscope was inserted through the mouth parallel to the endotracheal tube. The endotracheal tube cuff was deflated partially, and the standard flexible bronchoscope was driven into the anterior segment of the right upper lobe. The endotracheal tube cuff was then reinflated. A Fogarty catheter #5 was inserted through the working channel of the flexible bronchoscopy and inflated to completely occlude the anterior segment of the right upper lobe and block any potential bleeding. Once this precautionary strategy was implemented and under fluoroscopic guidance, multiple biopsies were obtained through the robotic catheter with a 23-G needle. No SAB was noted. Biopsy results were positive for malignancy showing poorly differentiated non-small cell carcinoma adenocarcinoma. The neoplastic cells were positive for pancytokeratin (AE1/AE3), cytokeratin 7, napsin A, and TTF-1, and negative for p40, PAX-5, CD68, CD79a, and CD45. Bronchoalveolar lavage showed no abnormal microbiology.

Discussion

The current RAB literature is in further need to determine safe practices in high-risk patients. The risk of SAB is about 2.4% [5]. This risk, however, does not involve patients with coagulopathy. SAB is a constant threat and techniques that minimize bleeding are certainly valuable for patients and expert bronchoscopists. Our approach involves a two-layer safety method as follows:

1. Optimization of haemostatic cascade:
   We used TEGs to determine the ideal haemostatic timing for patients to undergo invasive bronchoscopic procedures. TEG has been used as a point-of-care test to guide haemostasis. It has been shown to reduce transfusion requirements. TEG evaluates haemostasis as a whole entity rather than isolated invitro values. It achieves this by using visco-elastic changes in clotting whole blood under low shear conditions triggered by a clotting activator. Once blood starts to clot, fibrin strands are formed, and this increases the torque between the pin and the cup. These changes are registered electronically, and subsequently a specific timing for each clotting phase is determined [6].
   Our patient had previously shown transfusion-resistant thrombocytopenia and was also difficult to find HLA/cross-matched platelets. A standard safe platelet level of 50, 000 would have been not realistic and could have predispose fluid overload and future antigen intolerance.

2. Flexible bronchoscopy parallel to robotic bronchoscopy:
   Prior to transbronchial biopsies utilizing RAB, we advanced a flexible bronchoscope parallel to robotic catheter and used a Fogarty balloon to occlude the bronchial segment. In case an SAB had occurred, our approach and anticipation would have provided an extra layer of safety to limit airway bleeding consequences maximizing patient safety.

We overall recommend that RAB and other bronchoscopic procedures are performed under haemostatic TEG functional guidance rather than an absolute platelet number threshold, when thrombocytopenia or platelet dysfunction is suspected. The authors would consider performing flexible bronchoscopy parallel to robotic bronchoscopy and bronchial segmental balloon occlusion as a prevention measure for high-risk airway bleeding. These safety measures could also be applied during standard flexible bronchoscopy, a more frequent procedure, if the case involves a high risk of bleeding. More studies are needed to validate the overall efficacy of our technique to prevent bleeding during RAB.

Disclosure Statement

Appropriate written informed consent was obtained for publication of this case report and accompanying images.

Author Contribution Statement

All authors contributed evenly and approved the final manuscript.

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