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CASE SERIES

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Modified two-scope technique for transbronchial lung cryobiopsy of peripheral pulmonary lesions

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Abstract

Bleeding mitigation is an important part of any transbronchial lung cryobiopsy (TBLC) procedure, either for interstitial lung disease (ILD) or peripheral pulmonary lesions (PPL). The two-scope technique has been previously described for ILD and PPL-TBLC, but it has its own limitations and technical and logistical complexities. In this case series, we describe a modified two-scope technique that enhances the conventional two-scope technique by maintaining a small equipment footprint and longer bronchoscopic vision without the need for intra-procedure switching of bronchoscopes. Three cases of PPLs were navigated by standard radial endobronchial ultrasound and biopsied with the 1.1 mm flexible ultrathin cryoprobe. All cases achieved a conclusive diagnosis with adequate specimens for immunohistochemical staining and molecular analysis; only Grade 1 bleeding reported in two cases. The challenges and limitations of this modified two-scope technique were also explored in this series.

KEYWORDS
bleeding mitigation, interventional pulmonology, peripheral pulmonary lesion, transbronchial cryobiopsy, two scope system

INTRODUCTION

Transbronchial lung cryobiopsy (TBLC) was initially reported for the diagnosis of interstitial lung diseases (ILDs).[1] It has since then become a first-line biopsy tool, preceding surgical lung biopsy in patients with ILD who require histological examination.[2] Additionally, the utility of TBLC has also expanded to the diagnosis of peripheral pulmonary lesions (PPLs) as it provides high-quality specimens for immunohistochemistry and molecular studies, and potentially improves the diagnostic yield of adjacent orientated radial endobronchial ultrasound (rEBUS) lesions.[3,4]

However, despite its many benefits, bleeding remains more common in TBLC than with conventional forceps biopsy. Various bleeding mitigation techniques have been described, such as prophylactic balloon blockers, the tube-wedging method, and the two-scope technique.[5–8] The two-scope technique has been reported previously in both ILD-TBLC and PPL-TBLC.[7,8] In ILD-TBLC, two conventional bronchoscopy systems are employed, while in PPL-TBLC, a single bronchoscopy system is used. Despite their usefulness, these reported techniques have their own limitations with specific technical and logistical complexities.

The rapid advancement of single-use bronchoscopes post-COVID-19 pandemic has made them widely accessible, frequently equipped with compact and portable monitor consoles. Integrating a single-use bronchoscope with strong suction capabilities into TBLC procedures could potentially enhance the conventional two-scope technique. In essence, the portable single-use bronchoscope monitor (*DVM-A1*, Vathin, Hunan, China) is placed on the conventional bronchoscopy system tower, with both single-use and conventional bronchoscopes attached to their respective systems with separate dedicated suction. This setup enables the second operator with the single-use bronchoscope (*BCV1-M2*, VAthin® H-Steriscope™, Hunan, China) to swiftly enter the airway after the first operator performs *en-bloc* TBLC using the conventional bronchoscope.

In our centre, all PPLs are navigated using the bronchial branch tracing method and confirmed via rEBUS under fluoroscopy guidance with various sizes of reusable bronchoscopes and ancillary tools as previously described.[9]

TABLE 1 Details of PPL-TBLC cases with modified two-scope technique for bleeding mitigation.

	Case 1	Case 2	Case 3
Demographic and target lesion characteristic			
Age, *years*	70	68	64
Gender	Male	Female	Male
Co-morbidities	Hodgkin lymphoma in remission	Maxilla alveolar squamous cell carcinoma	Colorectal carcinoma & thyroid Microcarcinoma
Target size, *cm*	2.75	2.22	1.86
Target location	RB8-a-ii-β	RB2-b-ii-β-y	LB4-b-ii-β-y
Target nature	Solid	Solid	Solid
Bronchus sign	Type A	Type A	Type B
Procedure characteristic			
Airway access	Un-cuffed ETT	Cuffed ETT	Trans-oral *failed un-cuffed ETT*
Sedative agent	Midazolam & Fentanyl	Remi-fentanyl & Propofol	Midazolam & Fentanyl
Operating bronchoscope	BF-H190	BF-MP190F	BF-MP190F
rEBUS orientation	Concentric	Concentric	Eccentric
Cryoprobe size (mm)	1.1	1.1	1.1
Number of cryo-passes	3	3	2
Cryo freezing time (s)	6, 6, 8	8, 8, 8	8, 10
Procedure time (min)	20.0	35.0	18.0
Lag time (s)	8.53	12.18	40.05
Bleeding, *grade*	1	1	0
Other complication	Nil	Nil	Pneumothorax *self-limiting*
Outcome			
Specimen size, *mm*	7	6	5
Histology finding	Diffuse large B-cell lymphoma	Adenocarcinoma lung	Metastatic colorectal carcinoma

Abbreviations: ETT, endotracheal tube; rEBUS, radial endobronchial ultrasound.

Bleeding events are graded according to standard classification protocols.[10] Herein, we describe our initial experience with this modified two-scope technique in three patients with PPL-TBLC under rEBUS guidance. (Table 1, Figure 1, Video 1).

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Case 1

A 70-year-old male with Hodgkin lymphoma was referred with a 2.75 cm nodule at the fifth-generation airway of RB^8. An uncuffed siliconized endotracheal tube (ETT) was inserted under moderate sedation. Confirmation of a concentrically oriented rEBUS lesion was made using a diagnostic bronchoscope (*BF-H190*, Olympus Medical, Japan). TBLC was then performed with the *en-bloc* method using a 1.1 mm flexible cryoprobe (*ERBE*, Medizintechnik, Töbingen, Germany) under fluoroscopic guidance for three passes, each with freezing times ranging from 6 to 8 s. Both bronchoscopes alternate their roles as the first and second scope during the procedure to reduce procedural time. The average lag time between retrieval of the first scope and re-entry of the second scope to the target segment was 8.53 s. Grade 1 bleeding was noted with no other complications. Histological analysis revealed diffuse large B cell lymphoma, ABC type, confirmed through a panel of 16 immunohistochemical stains on the cryobiopsy specimen.

Case 2

A 68-year-old female with maxilla alveolar squamous cell carcinoma was referred for evaluation of a 2.2 mm nodule in the 6th generation airway of RB^2. The procedure was performed under total intravenous anaesthesia using a cuffed ETT with an ultra-thin bronchoscope (*UTB, BF-MP190F*, Olympus Medical, Japan). Confirmation of a concentric rEBUS lesion was followed by *en-bloc* TBLC using the 1.1 mm cryoprobe for 3 passes, each with 8 s of freezing time. The second scope enters swiftly after each TBLC to clear the bleeding and clots, allowing effective navigation by the UTB again. The average lag time between retrieval of the

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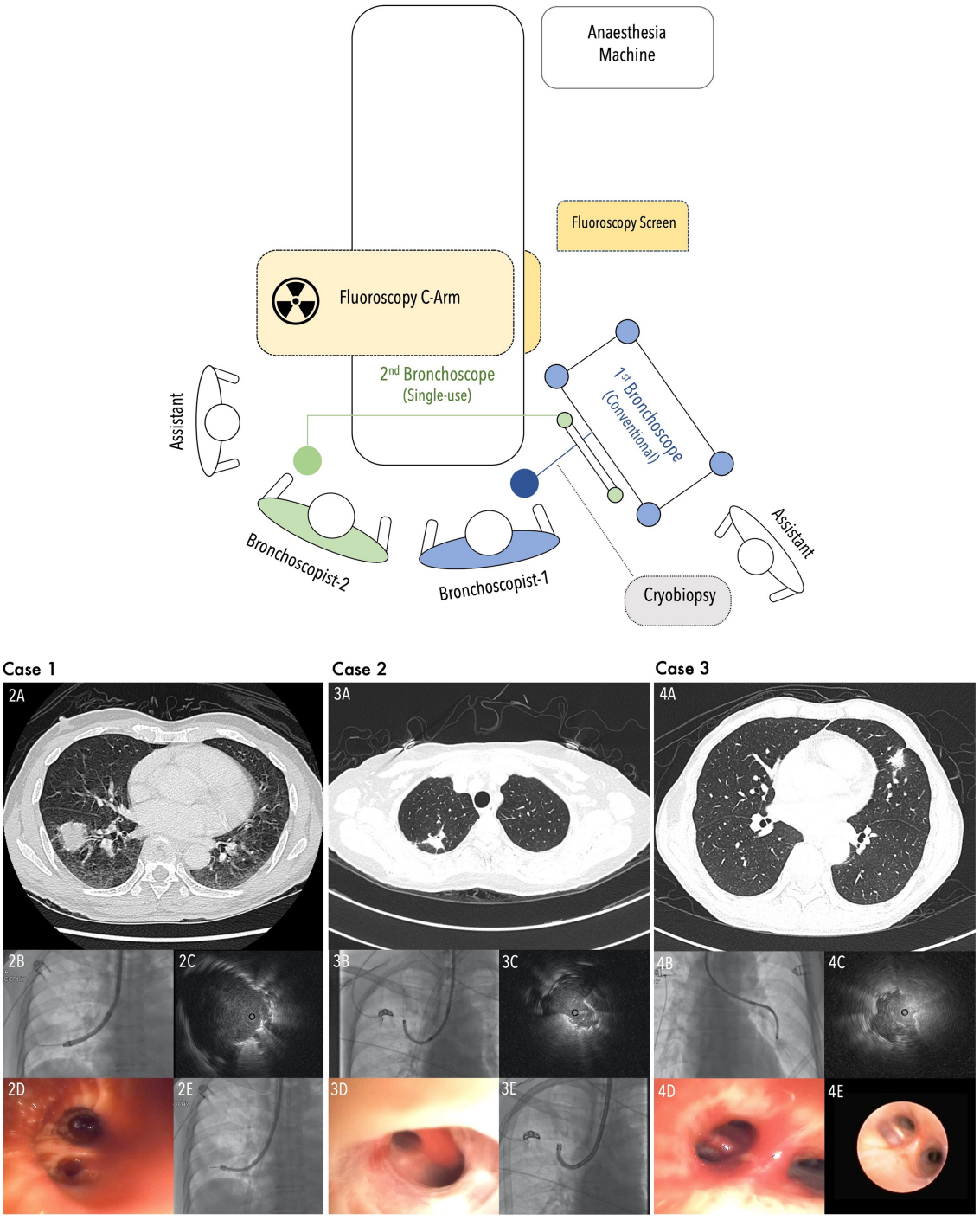
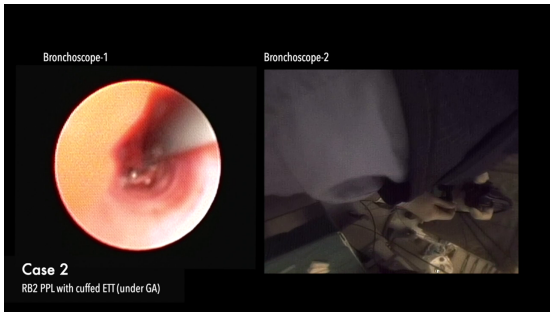


FIGURE 1 *Panel* (1): A schematic drawing of the arrangement in the bronchoscopy unit to accommodate the first bronchoscope (*blue*) and the second single-use bronchoscope (*green*) during an rEBUS-guided PPL-TBLC procedure. *Panel* (2) Case 1. (2A) A 2.75 cm target lung nodule situated in RB^8. (2B) The target was accessed with a diagnostic bronchoscope under fluoroscopy with rEBUS. (2C) Radial EBUS examination confirmed a concentrically oriented lesion at the target. (D) Bronchoscopic view from the single-use bronchoscope at the RB^8 ostium upon re-entry after TBLC. (2E) Subsequent round of rEBUS and cryobiopsy were performed with the single-use bronchoscope under fluoroscopic guidance. *Panel* (3) Case 2. (3A) A 2.22 cm target lung nodule in RB^2. (3B) The target was accessed with an ultrathin bronchoscope under fluoroscopy with rEBUS. (3C) Radial EBUS examination confirmed a concentrically oriented lesion at the target. (3D) Bronchoscopic view from the single-use bronchoscope at the RB^2 ostium upon re-entry after TBLC, all blood clots were aspirated to prepare for the next round of ultrathin bronchoscopy navigation and cryobiopsy. (3E) Fluoroscopic view of the single-use bronchoscope wedged at the RB^2 ostium. *Panel* (4) Case 3. (4A) A 1.86 cm target lung nodule in LB^4 (4B) The target was accessed with an ultrathin bronchoscope under fluoroscopy with rEBUS. (4C) Radial EBUS examination confirmed an eccentrically oriented lesion at the target. (4D) Bronchoscopic view from the single-use bronchoscope at the LB^4 ostium upon re-entry after TBLC with no bleeding observed. (4E) Bronchoscopic view from the ultrathin bronchoscope at the LB^4 ostium ready for another round of navigation and TBLC.



VIDEO 1 Video summarizing the key procedural steps of modified two-scope technique in all three cases.
Video content can be viewed at https://onlinelibrary.wiley.com/doi/10.1002/rcr2.1450

first scope and re-entry of the second scope to the target segment was approximately 12.18 s. Grade 1 bleeding occurred with no other complications reported. The specimen measured 6 mm in total aggregate diameter, was histologically confirmed to be lung adenocarcinoma with exon 21 (L858R) epidermal growth factor receptor mutation, indicating a synchronous primary lung cancer.

Case 3

A 64-year-old male with underlying colorectal carcinoma and thyroid microcarcinoma was referred for assessment of a 1.86 cm nodule in the 6th generation airway of LB^4 with pleural tagging. The procedure was conducted under conscious sedation without an artificial airway, as attempts to insert an uncuffed siliconized ETT were unsuccessful due to limited neck extension from recent thyroid surgery. An eccentrically oriented rEBUS lesion was confirmed using an UTB. Two passes of *en-bloc* TBLC were performed using the 1.1 mm cryoprobe, with freeze times of 8 and 10 s each. The average lag time was 40.05 s. Grade 0 bleeding were reported, but the patient experienced a self-limiting pneumothorax post-procedure. The cryobiopsy specimen measured 5 mm in total aggregate, was histologically confirmed to be metastatic colorectal carcinoma following immunohistochemistry staining that showed positivity for CK20 and SATB2, and negative for TTF-1 and CK7.

DISCUSSION

Bleeding mitigation is crucial in TBLC procedures. Prophylactic balloon blockers are recommended for ILD-TBLC and are usually technically straightforward since most pathological sites are in the lower lobes.[5] However, PPLs are often found in the upper lobes, especially when malignant diseases are suspected.[11] Placing a balloon blocker in these regions can be challenging, particularly in the apical segments of the upper or lower lobe, and they tend to dislodge easily even when placed successfully. Moreover, balloon blocker can potentially induced atelectasis in the target segment which may hinder repeated rEBUS verification, especially for smaller PPLs in the dependent segments.[12]

The two-scope technique has been described in the literature for TBLC procedures.[7,8] Sriprasart et al. detailed the conventional two-scope method for ILD-TBLC, using two different bronchoscopes with two separate bronchoscope systems.[8] While effective, this approach can be cumbersome as it requires both systems to be present simultaneously, creating a large footprint in a small bronchoscopy suite. Nakai et al. described a variation of this technique for PPL-TBLC, where only one bronchoscope system is used.[7] Prior to cryoactivation, the first operator relies solely on fluoroscopic vision when the first scope is detached and the second scope is connected.[7] This technique demands a learning curve for the team to master and orchestrate the steps involved.

In contrast, our modified two-scope technique uses a single-use bronchoscope with a small monitor console, combining the advantages of both methods described previously by maintaining a small footprint and longer bronchoscopic vision without the need for intra-procedure switching of bronchoscopes. Moreover, for procedures that only require a diagnostic bronchoscope, the single-use scope can be used as the primary scope for rEBUS localization and cryobiopsy after re-entry, as demonstrated in Case 1, potentially reducing overall procedural time. For cases that required an UTB, the single-use bronchoscope provides optimal suction and airway clearance of clots to allow easier access for the UTB for subsequent rounds of navigation and biopsy, which itself has very limited suction capability.

However, a few challenges remained for this modified technique. First, the lag time between the removal of the first conventional bronchoscope and the re-entry of the second single-use bronchoscope to wedge into the target segment was still significant, especially when an artificial airway was not in place pre-TBLC. Thus, any bleeding could occur unchecked during this blind period, potentially leading to airway flooding and asphyxiation. However, the degree of bleeding mitigation required in ILD-TBLC and PPL-TBLC may not be the same, as the patient profiles frequently differed.[7,13] Patients with PPL generally had better reserves and could potentially tolerate bleeding better than frail ILD patients, allowing for some leeway in the lag time.[7,13] Second, an alternative method for PPL-TBLC using the 1.1 mm cryoprobe is the sheath-retrieval method, where physicians have demonstrated feasibility by retrieving the cryobiopsy specimen via the guide sheath or the working channel of the bronchoscope.[14,15] Although this technique allows the bronchoscope to stay in the airway and remain wedged to control any bleeding, it generally yielded specimen with small size.[14,15] In our experience in resource-limited regions, where thoracic pathology services are still scarce, a larger specimen is always preferred for confident diagnosis via morphological analysis, immunohistochemistry staining, and molecular analysis. Lastly, cost might be prohibitive as a single rEBUS-TBLC procedure will now require both the single-use flexible cryoprobe and bronchoscope.

In conclusion, the modified two-scope technique may potentially be an effective way for bleeding mitigation in PPL-TBLC procedures by offering a simpler setup and a more straightforward approach. A larger study to assess its feasibility and cost-effectiveness will be anticipated.

AUTHOR CONTRIBUTIONS

Sze Shyang Kho initiated the idea for case series reporting and prepared the final copy of the manuscript. Sze Shyang Kho and Chan Sin Chai were the operator for all three TBLC procedures and were involved in the overall patient management. Adam Malik Ismail analysed the biopsy specimen and was the supervising thoracic pathologist for all three cases. All authors had read and approved the final version of this manuscript.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, SSK, upon reasonable request.

ETHICS STATEMENT

For this case series, the authors declare that appropriate written informed consent was obtained for the publication of this manuscript and accompanying images.

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