Two-bronchoscope technique for cryoextraction: An alternative approach for the removal of endobronchial thrombi in children

Ryne Simpson[1], Isabel Virella-Lowell[1], Hitesh Batra[2], and Guillermo Beltran Ale[1]

[1]Division of Pediatric Pulmonary and Sleep Medicine University of Alabama at Birmingham Birmingham AL
[2]Division of Pulmonary Allergy and Critical Care Medicine University of Alabama at Birmingham Birmingham Alabama

June 21, 2022

Abstract

This case illustrates another promising example of the recent advances within pediatric interventional bronchoscopy. As innovative medical therapies continue to make their way into the pediatric realm (e.g. a 1.1-mm flexible cryoprobe has been recently developed by Erbe), opportunities for novel approaches and techniques will continue to present themselves.

Two-bronchoscope technique for cryoextraction: An alternative approach for the removal of endobronchial thrombi in children

To the Editor:

Cryotherapy has become an important aspect of pediatric interventional bronchoscopy. Through application of the Joule-Thompson effect, cryotherapy utilizes freeze-thaw cycles via rapid expansion of pressurized gas [1]. Bronchoscopic cryoextraction (i.e. using cryotherapy to remove material *en bloc* from the airway) has shown promise for the removal of large mucus plugs, obstructive thrombi, and foreign bodies in children [2, 3]. Although there are no reports of serious complications related to cryoextraction in children, the risk of hemorrhage is likely enhanced in coagulopathic patients, including those receiving anticoagulation for extracorporeal membrane oxygenation (ECMO) support. Because the bronchoscope and cryoprobe must be removed in tandem to extricate foreign material, there is a period of time when visualization of the airway is lost. As such, the ability to quickly address complications is hampered.

Sriprasart et al. described a 2-bronchoscope approach in adults undergoing cryobiopsy for undiagnosed interstitial lung disease (ILD) [4]. By utilizing an additional bronchoscope with a patent suction/instrumentation channel, this approach minimized time outside of the patient's airway and facilitated prompt hemostasis following lung tissue removal. In this report, which we believe to be the first of its kind, we describe a similar technique performed in a pediatric patient undergoing cryoextraction of a massive airway thrombus secondary to prolonged ECMO support.

Patient Case

An 11-year-old female with a recent diagnosis of acute myeloid leukemia developed respiratory failure following chemotherapy induction. Progression of her respiratory failure led to initiation of venous-venous ECMO (VV-ECMO) and concomitant anticoagulation. While on VV-ECMO, the patient developed recurrent, consolidative opacifications on chest imaging consistent with large airway obstruction. Over the course of 3 weeks, the patient underwent 8 therapeutic bronchoscopies to remove mucus plugs and large endobronchial thrombi. Several approaches (including standard suctioning, saline lavage, and alligator forceps) were trialed

with decreasing benefit. Ultimately, radiography demonstrated complete opacification of the thorax [Figure 1A], and flexible bronchoscopy revealed thrombus extending upwards into the ETT [Figure 1C]. Otolaryngology was consulted, however, the patient's tenuous status precluded endotracheal tube (ETT) removal and rigid bronchoscopy. At that time, the decision was made to attempt thrombus removal via cryoextraction.

The Endoscopic Technique

Two pulmonologists and one respiratory therapist were present at the time of cryoextraction. Two bronchoscopes (Olympus BF-P180, Olympus, Tokyo, Japan) were utilized and each controlled by a separate pulmonologist. A single Olympus endoscope video cart was used. An Erbe (Tubingen, Germany) 1.9-mm multi-use cryoprobe was inserted through the 2.0 mm working channel of 1 bronchoscope and advanced into the center of the thrombus. Freeze times of 5 - 15 seconds were utilized to adhere to the proximal end of the thrombus, being mindful to avoid contact with the ETT or tracheobronchial wall. The bronchoscope and cryoprobe (with attached thrombus) were withdrawn en bloc. Immediately following bronchoscope removal, the assisting respiratory therapist disconnected the bronchoscope-cryoprobe from the video cart and connected the second bronchoscope, already in the hands of the other pulmonologist. This second bronchoscope, with a clean lens and patent suction channel, was inserted into the ETT to assess the airway and control bleeding. Once bleeding was controlled, any fresh blood obfuscating the remaining thrombus was cleared in preparation for repeat cryoextraction. The bronchoscopes were then disconnected-reconnected in the same fashion until the entire thrombus extending from the distal trachea to the left subsegmental bronchi was removed [Figures 1B and 1D]. Due to increasing degrees of active bleeding at the proximal portion of the right main bronchus, dilute epinephrine was instilled near the carina. The procedure was then terminated with plans for cryoextraction of the right side at a later date. The second procedure was performed 7 days later in the same manner, and the entire tracheobronchial tree was subsequently cleared of obstruction [Figure 2]. Roughly 1 week following cryotherapy, the patient was taken off of ECMO and ultimately extubated to non-invasive positive pressure ventilation.

Discussion:

Bronchoscopic cryotherapy has become increasingly prevalent within pediatric pulmonary medicine. This has been largely due to the development of smaller cryoprobes more suitable for use in children [1, 2]. Nevertheless, cryotherapy does have potential for harm, and adequate care must be taken to ensure the safety of the patient [5]. This case highlights some of the drawbacks associated with cryoextraction (namely loss of airway visualization and inoperative suction channel) and offers a solution similar to what has been described by a center performing cryobiopsy in adults with ILD.

The 2-bronchoscope approach described here does not, in theory, require 2 separate pulmonologists. The authors describing the initial technique only utilized a bronchoscopist and an assistant. It is assumed that the authors had separate modalities for viewing each bronchoscope which would obviate the need for 'disconnection-reconnection' mentioned in this paper. Because our case occurred in the pediatric intensive care unit, there was not enough physical space for 2 separate mobile carts (in addition to the endoscopy cart, both ECMO and continuous renal replacement therapy circuits were present). Although a single proceduralist would have likely sufficed, we believe there was benefit in having 2 physicians share the workload and discuss the case in real-time. As an example, utilizing 2 providers allowed for intermittent cleaning of the bronchoscope and cryoprobe (a potentially time-consuming process due to friction associated with insertion/removal of the 1.9 mm probe in a 2.0 mm channel) while preserving suction capabilities and airway visualization. For these reasons, if qualified staff are available, we would recommend having more than 1 bronchoscopist present for this technique.

Although this report focuses primarily on the technical aspects of the case, the overall performance of bronchoscopic cryotherapy should not go unrecognized. As was previously mentioned, numerous time-consuming and unsuccessful attempts at thrombus removal were made prior to cryoextraction. This case illustrates another promising example of the recent advances within pediatric interventional bronchoscopy. As innovative medical therapies continue to make their way into the pediatric realm (e.g. a 1.1-mm flexible cryoprobe has

been recently developed by Erbe), opportunities for novel approaches and techniques will continue to present themselves.

References:

1. J. Piccione, EB. Hysinger, AG. Vicencio. Pediatric advanced diagnostic and interventional bronchoscopy. Seminars in Pediatric Surgery. Volume 30, Issue 3 2021. ISSN 1055-8586. https://doi.org/10.1016/j.sempedsurg.2021.151065.
2. J.J. Brewington, *et al.* Flexible bronchoscopic thrombus cryoextraction in a neonate on extra-corporeal membrane oxygenation. Am J Respir Crit Care Med (2020).
3. K. Engelhardt, *et al.* Successful use of pulmonary cryotherapy for tracheobronchial thrombus extraction and recanalization of the tracheobronchial tree during a pediatric venovenous extracorporeal membrane oxygenation run. Pediatr Allergy Immunol Pulmonol, 32 (1) (2019), pp. 28-30.
4. Sriprasart T, Aragaki A, Baughman R, Wikenheiser-Brokamp K, Khanna G, Tanase D, Kirschner M, Benzaquen S. A Single US Center Experience of Transbronchial Lung Cryobiopsy for Diagnosing Interstitial Lung Disease With a 2-Scope Technique. J Bronchology Interv Pulmonol. 2017 Apr;24(2):131-135. doi: 10.1097/LBR.0000000000000366. PMID: 28323726; PMCID: PMC5367496.
5. Hammer J, Trachsel D, Nicolai T, Weiss M, Eber E. Caution to use bronchoscopic CO2 cryotherapy for foreign body removal in children. Pediatr Pulmonol. 2016 Sep;51(9):889-91. doi: 10.1002/ppul.23450. Epub 2016 Apr 29. PMID: 27128205.

Authors:

Ryne Simpson MD[1, 2], Isabel Virella-Lowell MD[1, 2], Hitesh Batra MD[3, 4], Guillermo Beltran Ale MD[1, 2]

[1]Division of Pediatric Pulmonary and Sleep Medicine, University of Alabama at Birmingham, Birmingham, AL

[2]Department of Pediatrics, University of Alabama at Birmingham, Birmingham, AL

[3]Division of Pulmonary, Allergy, and Critical Care Medicine, University of Alabama at Birmingham, Birmingham, Alabama

[4]Department of Medicine, University of Alabama at Birmingham, Birmingham, AL

Institution:

University of Alabama – Birmingham

Department of Pediatrics, Division of Pediatric Pulmonary and Sleep Medicine

1600 7th Avenue South

Birmingham, AL 35233

Financial Disclosure:

The authors declare they have no relevant financial interests.

Conflicts of Interest:

The authors declare they have no conflicts of interest.

Correspondence to:

Ryne Simpson, MD

University of Alabama – Birmingham

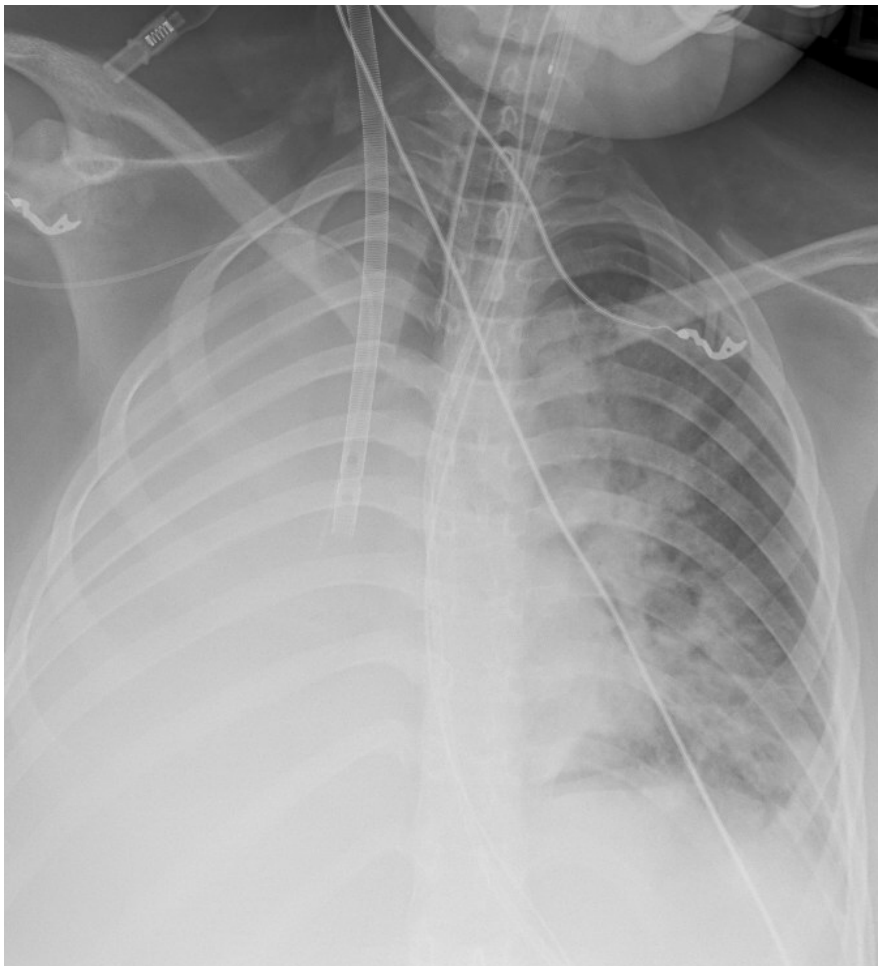
Department of Pediatrics, Division of Pulmonary and Sleep Medicine

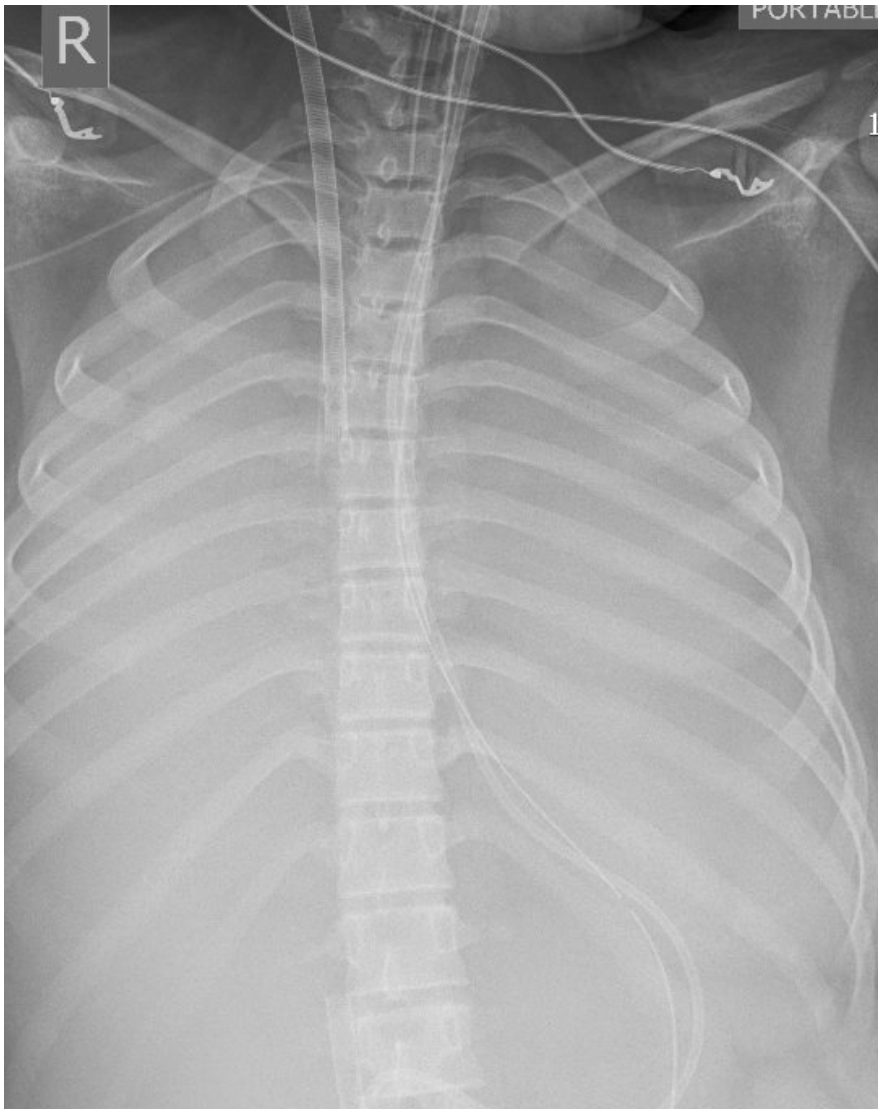
620 Jarman F. Lowder Building

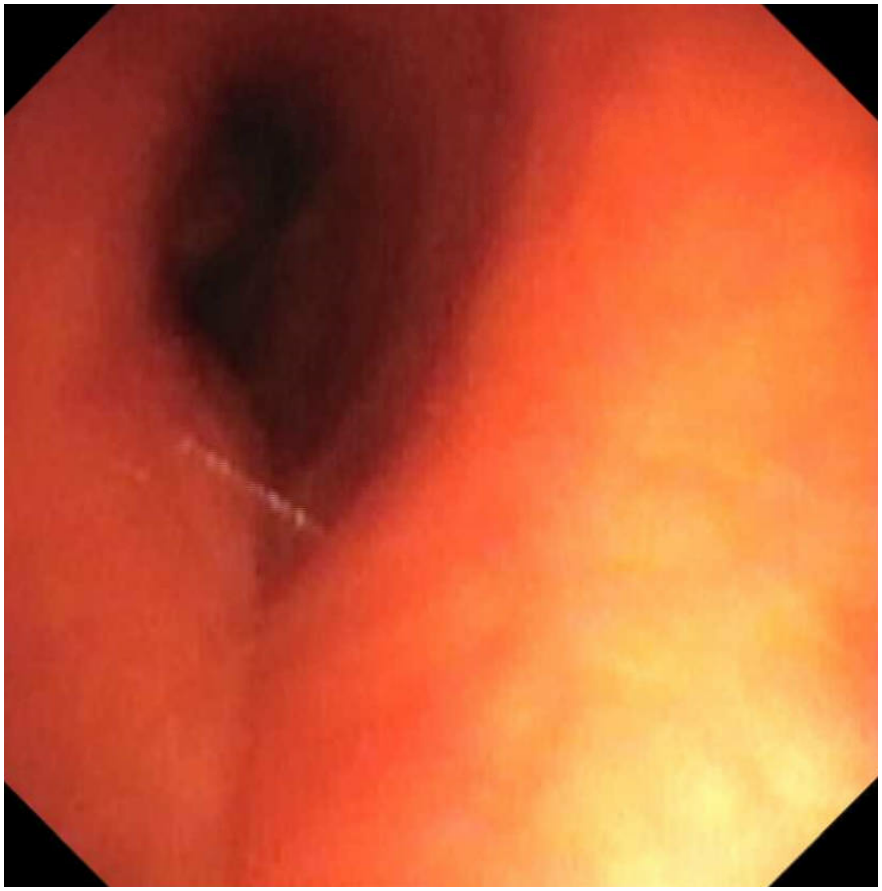
1600 7th Avenue South

Birmingham, AL 35233

Email: rcsimpson@uabmc.edu







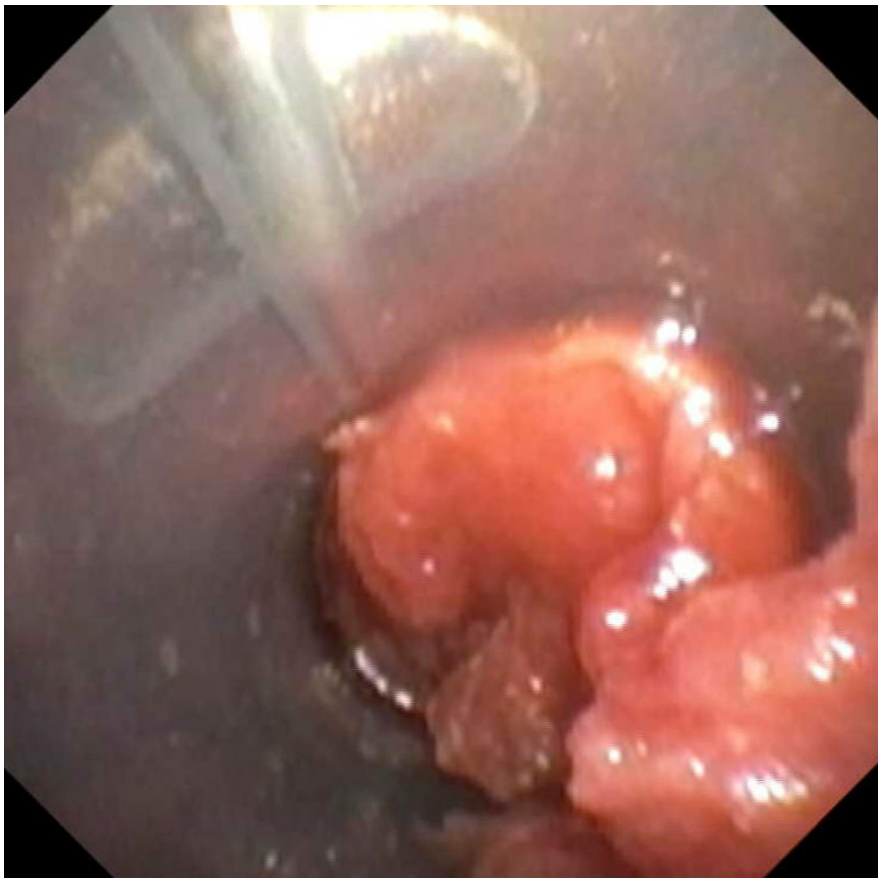
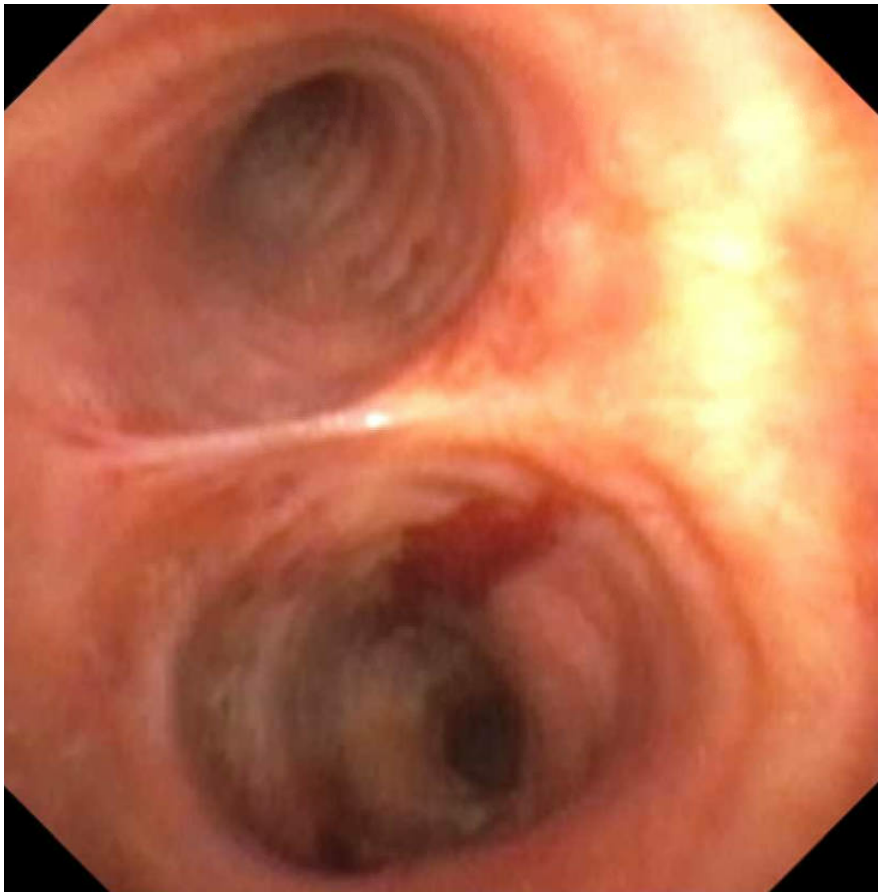


Figure 1. Chest radiograph before (A) and after (B) cryoextraction. Thrombus extending upwards into the distal endotracheal tube (C) and patent left main bronchus following cryoextraction (D).



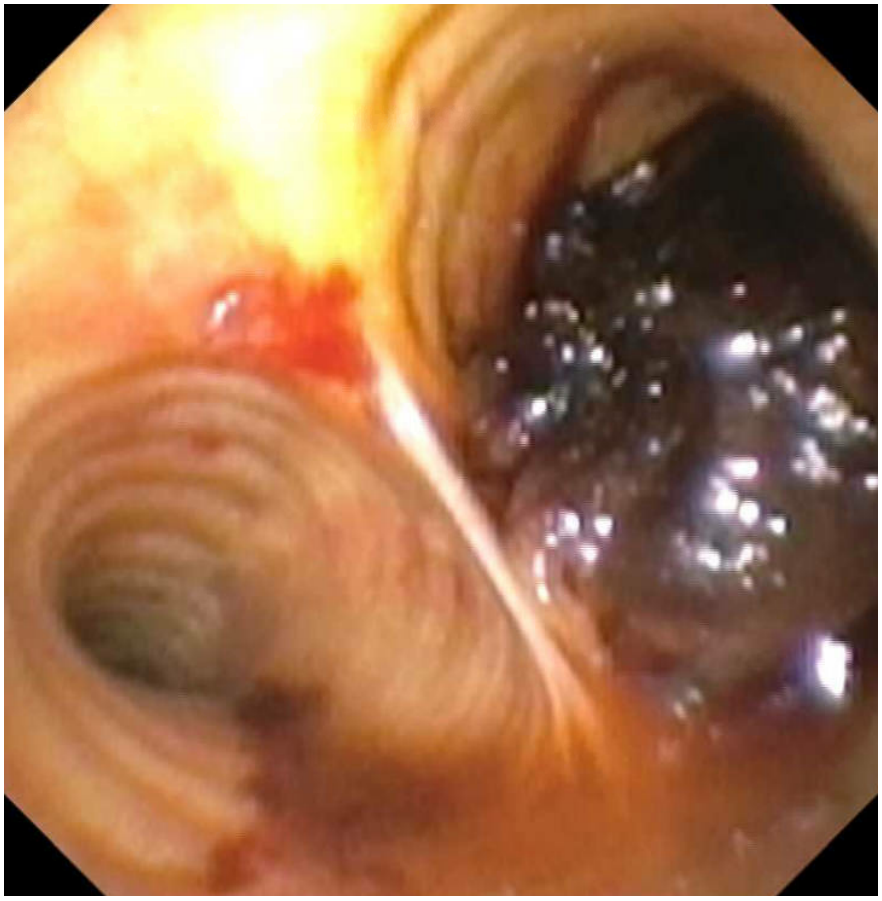


Figure 2. Right main bronchial thrombus, before and after cryoextraction.