

# Novel Treatment of Mucous Plugging Causing Left Lung Atelectasis in a Premature Neonate Weighing <500 Grams Using Flexible Fiberoptic Bronchoscopy

Tiffany G Campbell, MD, Juan C Martinez, MD, FAAP, Doron J Kahn, MD, FAAP

## Abstract:

**Introduction:** Improved survival rates in extremely low birth weight (ELBW) neonates require smaller instruments and newer techniques to manage atelectasis in neonates on mechanical ventilation.

**Case presentation:** A chronically ventilated 23-week gestational age neonate weighing 465g developed worsening respiratory distress on day of life 17. X-rays showed complete opacification of the left lung. Flexible fiberoptic bronchoscopy (FFB) was performed with a 2.2 mm bronchoscope through the endotracheal tube (ETT), where an occlusive mucus plug was visualized in the left mainstem bronchus. Due to the lack of suction capability with this bronchoscope and inability to pass a larger one, the bronchoscope was positioned proximal to the mucous plug, the ETT was advanced over the bronchoscope, thereby selectively intubating the left mainstem bronchus, the bronchoscope was removed, an 8Fr suction catheter was inserted, and suction was applied resulting in successfully removal of the mucous plug. Immediate clinical improvement and re-aeration of the left lung were noted.

**Conclusion:** This case introduces a novel FFB technique to manage left lung atelectasis in critically ill ELBW neonates

*“Improved survival rates at the border of viability (22-24 weeks gestation) necessitate smaller instruments and newer techniques to manage complications in these extremely low birth weight (ELBW) neonates. Atelectasis occurs commonly in neonates on mechanical ventilation. Bronchoalveolar lavage with rigid and flexible fiberoptic bronchoscopy (FFB) is a treatment option for atelectasis.”*

## Introduction:

Improved survival rates at the border of viability (22-24 weeks gestation) necessitate smaller instruments and newer techniques to manage complications in these extremely low birth weight (ELBW) neonates. Atelectasis occurs commonly in neonates on

mechanical ventilation. Bronchoalveolar lavage with rigid and flexible fiberoptic bronchoscopy (FFB) is a treatment option for atelectasis. Currently, the smallest pediatric bronchoscopes with and without suction catheters measure 2.8 mm and 2.2 mm, respectively. FFB can be performed directly into the trachea of a spontaneously breathing patient or through an endotracheal tube (ETT). The flexible bronchoscope must be small enough to allow for ventilation, which is challenging in the ELBW neonate (1). The ultrathin 2.2 mm bronchoscope is advantageous in ELBW neonates intubated with ETts of size 2.5 mm and 3.0 mm. However, the lack of a suction channel limits its use for diagnostic purposes. While blind suctioning is often feasible in the trachea and right mainstem bronchus, the anatomy of the left mainstem bronchus poses a challenge for access.

We describe a novel technique to suction the left mainstem bronchus in a critically ill 23 (corrected age 25) week neonate weighing 470 grams with complete left lung atelectasis due to mucous plugging.

*“We describe a novel technique to suction the left mainstem bronchus in a critically ill 23 (corrected age 25) week neonate weighing 470 grams with complete left lung atelectasis due to mucous plugging.”*

## Case presentation:

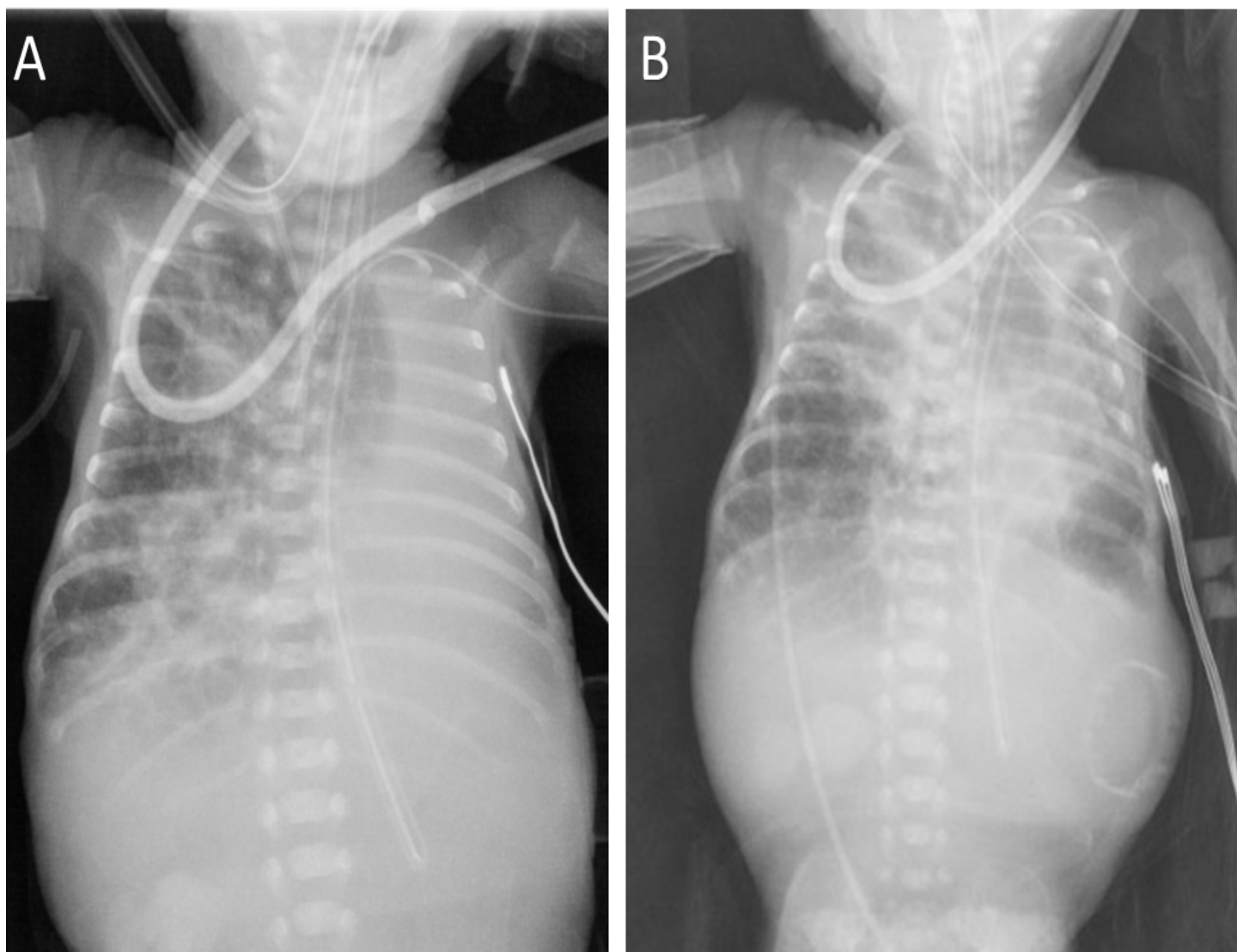
A male neonate with a birth weight of 465 grams was born at 23-week and 1-day gestation to a 39-year-old G2P1 female via cesarean section due to prolonged rupture of membranes and non-reassuring fetal heart tones. Apgar scores were 1, 6, and 7 at 1, 5, and 10 minutes, respectively. He required endotracheal intubation at birth due to respiratory insufficiency, high-frequency jet ventilator, and surfactant on day of life (DOL) 1, 2 and 4. His course was complicated by respiratory distress syndrome, persistent pulmonary hypertension of the newborn, spontaneous intestinal perforation, bilateral grade 4 intraventricular hemorrhage, and portal vein thrombosis. A peritoneal drain was placed for spontaneous intestinal perforation on DOL 4, but due to continued stool drainage and hemodynamic compromise, a laparotomy with resection of focal perforation and placement of ostomy with mucous fistula was performed on DOL 15. Post-op, he was supported on the high-frequency jet ventilator with a fraction of inspired oxygen (FiO<sub>2</sub>) of 45% and no longer required vasopressors. However, after brief post-op clinical improvement, on DOL 17, he had worsening respiratory distress with FiO<sub>2</sub> up to 100%. Inhaled nitric oxide for

hypoxemic respiratory failure and vasopressors for hemodynamic decompensation were started. On x-ray, complete opacification of his left lung was noted (shown in Fig. 1A). Multiple strategies to resolve the atelectasis such as various ventilators, ventilator strategies, different body positionings, frequent saline lavage, and pulmozyme, were attempted but were ineffective. After 36 hours of unsuccessful conventional interventions, FFB was performed by pediatric pulmonology on DOL 19.

His respiratory and hemodynamic instability precluded extubation, so a 2.2 mm Olympus ultrathin BF-N20 bronchoscope was advanced through the existing 2.5 mm ETT into the trachea and the right and left mainstem bronchus. A large, occlusive mucous plug was visualized approximately 1-2 cm into the left mainstem bronchus. Due to a lack of attached suction capabilities, the bronchoscope was removed from the airway and multiple blind attempts to suction the mucous plug were performed. Post-suctioning FFB demonstrated persistence of the mucous plug, and attempts to

advance the bronchoscope through or beyond the plug were unsuccessful. The patient tolerated the procedure well, however, after 2 hours of various interventions, it was abandoned. Trials of conventional therapies continued throughout that night; however, hemodynamic instability continued, thus FFB was reattempted.

On DOL 20, despite his weight of <500 grams, a 3.0 ETT was inserted to pass the larger 2.8 mm bronchoscope. Unfortunately, the passage was unsuccessful; thus, FFB was repeated using the 2.2 mm ultrathin bronchoscope. (shown in Fig. 2A) With the occlusive plug visualized and the scope tip just proximal to the mucous plug, the ETT was advanced over the bronchoscope to be situated at the mucous plug in the left mainstem bronchus (shown in Fig. 2B) The bronchoscope was removed, and an 8Fr suction catheter advanced just distal to the end of the ETT. (shown in Fig. 2C). The mucous plug was successfully removed as suction was applied. Post-procedure, there was clinical improvement with lowering of  $\text{FiO}_2$  to 50% and discontinuation of inhaled nitric oxide



*Figure 1: Before and after radiographic images of left lung atelectasis*

*A. Spontaneous development of left lung atelectasis*

*B. resolution of atelectasis a few hours post direct suctioning of left mainstem bronchus mucous plug*

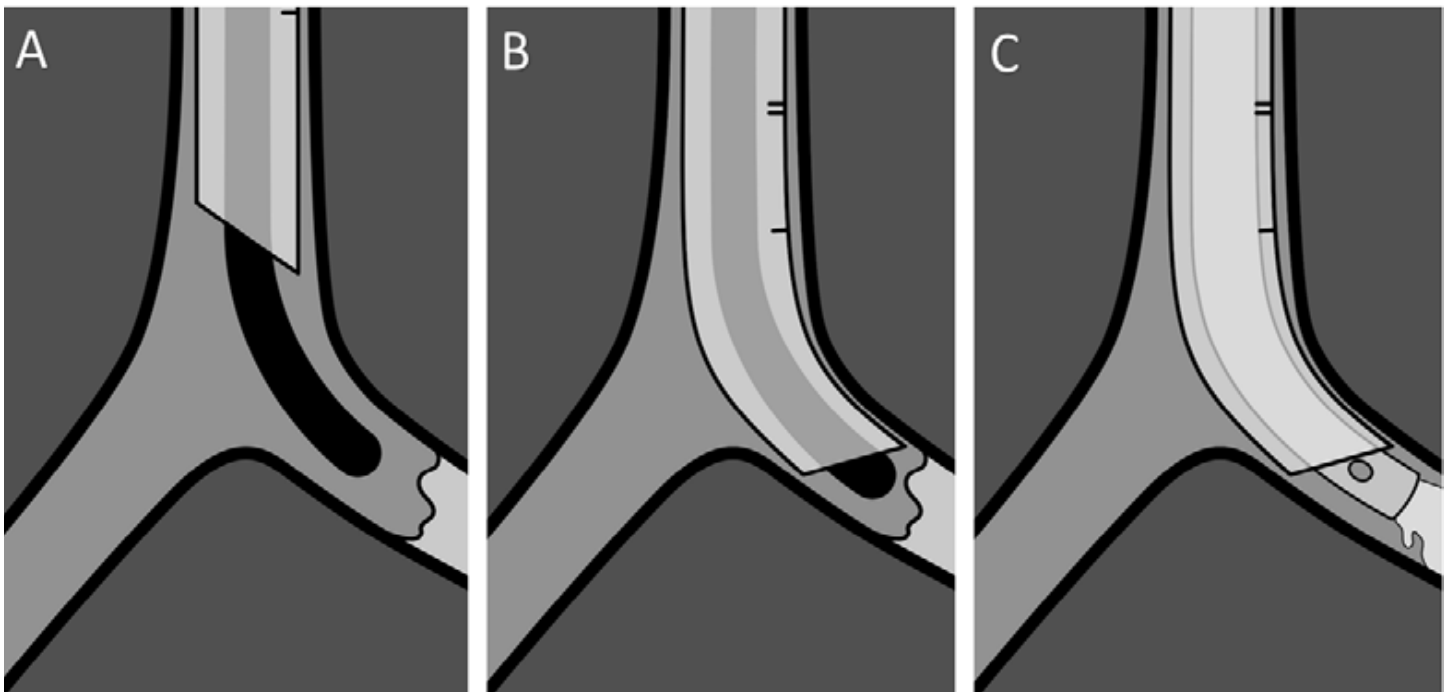


Figure 2: The procedure to remove the left mainstem bronchus mucous plug when suctioning via direct bronchoscopy is not possible

A. Visualize mucous plug via direct bronchoscopy through existing ETT

B. Pass ETT over the bronchoscope so it sits within the left mainstem bronchus just proximal to the mucous plug

C. Remove the bronchoscope and insert the suction catheter through the existing ETT

and vasopressor support. The immediate post-procedure x-ray demonstrated improved left lung volume (shown in Fig. 1B).

***“FFB is documented to be safe and effective in assessing and treating infants and children with a wide variety of respiratory diseases, including atelectasis (3-6).”***

#### Discussion:

FFB in young children was first described in 1978 (2). FFB is documented to be safe and effective in assessing and treating infants and children with a wide variety of respiratory diseases, including atelectasis (3-6). In two large cohorts of 559 and 116 infants undergoing FFB, the smallest infants were 1180 grams and 750 grams, respectively (7, 8). In a retrospective case series by Sachdev et al., FFB performed in neonates with birth weights 820-3660 grams caused resolution of atelectasis within 24 hours in 20 out of 25 cases of persistent atelectasis (6). Fan et al. describe successful resolution of lung atelectasis due to mucous plugging in a 658-gram neonate, however, this was with a rigid bronchoscope, off ventilator support, and with atelectasis and mucous plugging on the right side (9). Other case series describe successful resolution of lung atelectasis, including left-sided atelectasis, however, the smallest patients in these cohorts were typically more than 1000 grams. Most of these patients could be extubated for the procedure, and those who remained intubated

were scoped through a size 3.5mm ETT or larger in whom FFB with an attached suction device was feasible (3, 10). Our patient's size and clinical instability made him an unsuitable candidate for extubation, and since he was too small for a 3.5 mm ETT, we were limited to the 2.2 mm bronchoscope without a suction device. To our knowledge, there has been no other case report of a critically ill, intubated, less than 500-gram neonate undergoing therapeutic FFB into the left mainstem bronchus. We describe a technique to suction the often difficult-to-reach left mainstem bronchus in the smallest neonates in which conventional bronchoscopy equipment may be inadequate.

#### References:

1. Wood RE, Sherman JM. Pediatric flexible bronchoscopy. *Ann Otol Rhinol Laryngol*. 1980;89(5):414-6.
2. Wood RE. Bronchoscopy and bronchoalveolar lavage in pediatric patients. In: Wilmot RW, Deterding R, Li A, et al, eds. *Kendig's Disorders of the Respiratory Tract in Children*. 9<sup>th</sup> ed. Elsevier; 2019. P 134-36.
3. De Blic J, Delacourt C, Scheinmann P. Ultrathin flexible bronchoscopy in neonatal intensive care units. *Arch Dis Child*. 1991;66(12):1383-5.
4. Faro A, Wood RE, Schechter MS, Leong AB, Wittkugel E, Abode K, et al. Official American Thoracic Society technical Standards: Flexible airway endoscopy in children. *Am J Respir Crit Care Med*. 2015;191(9):1066-80.
5. Hysinger E, Friedman N, Jensen E, Zhang H, Piccione J. Bronchoscopy in neonates with severe bronchopulmonary dysplasia in the NICU. *J Perinatol*. 2018;39(2):263-8.

6. Sachdev A, Chhawchharia R, Gupta D, Gupta N. Flexible fiberoptic bronchoscopy directed interventions in neonatal intensive care unit. *Indian Pediatr.* 2019;56(7):563–5.
7. Mackangee HR, Naidoo L, Ramkaran P, Sartorius B, Chuturgoon AA. Neonatal bronchoscopy: Role in respiratory disease of the newborn – a 7 year experience. *Pediatr Pulmonol.* 2019;54(4):415-20.
8. Ke LQ, Shi MJ, Zhang FZ, Wu HJ, Wu L, Tang LF, et al. The clinical application of flexible bronchoscopy in a neonatal intensive care unit. *Front Pediatr.* 2022;10:2296-2360.
9. Fan PC, Teng RJ, Chen JC, Huang CH, Tsou Yau KI. Rigid bronchoscopy and jet ventilation in an extremely low birth-weight infant. *J Formos Med Assoc.* 1996;95(12):937
10. Kohelet D, Arbel E, Shinwell ES. Flexible fiberoptic bronchoscopy – a bedside technique for neonatologists. *J Matern Fetal Neonatal Med.* 2011;24(3):531-5.



Juan C Martinez, MD, FAAP  
Division of Pulmonology  
Joe DiMaggio Children's Hospital  
Hollywood, FL, USA

**Acknowledgment:** The authors thank Ari Hoffman for the renderings in Figure 2. Ari Hoffman is a fourth-year dental student at Touro College of Dental Medicine in New York and does dental cartoons for American Dental Association Print News. He has no conflicts of interest or funding sources related to this rendering.

**Statement of Ethics:** Written informed consent was obtained from the parents to publish this case report and accompanying images.

**Disclosure:** The authors have no conflicts of interests to disclose.

**NT**

#### Corresponding Author



Tiffany G Campbell, MD  
Department of Pediatrics  
Joe DiMaggio Children's Hospital  
Hollywood, FL, USA  
Tel#: (954) 265-5830  
email: [tifcampbell@mhs.net](mailto:tifcampbell@mhs.net)



Doron J Kahn, MD, FAAP  
Division of Neonatology and Perinatal Medicine  
Joe DiMaggio Children's Hospital  
Hollywood, FL, USA