

## Flexible Bronchoscopy for Respiratory Problems in Neonate

Sarabon Tahura<sup>1\*</sup> and Aftab Yusuf Raj<sup>2</sup>

<sup>1</sup>Associate Professor, Department of Paediatric Respiratory Medicine, Bangladesh Institute of Child Health, Dhaka Shishu (Children) Hospital, Bangladesh

<sup>2</sup>Senior Consultant, Department of Neonatology and Paediatrics, Square Hospitals Ltd, Bangladesh

\*Corresponding Author: Sarabon Tahura, Associate Professor, Department of Paediatric Respiratory Medicine, Bangladesh Institute of Child Health, Dhaka Shishu (Children) Hospital, Bangladesh.

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### Abstract

**Background:** Though Flexible bronchoscopy has been well established for diagnostic and therapeutic purposes in respiratory problems, is still rarely used in neonates. Now-a-days, the availability of thin and ultrathin flexible bronchoscope allows the bronchoscopy in intubated mechanically ventilated neonates. This study aimed to outline the clinical evidence of the utility and safety of flexible bronchoscopy by thin flexible bronchoscope for evaluation and management of respiratory problems in neonate.

**Materials and Methods:** A total 18 neonates who underwent bronchoscopy by thin (Outer diameter 2.8 mm with 1.2 mm action Channel) flexible bronchoscope, were reviewed retrospectively. Among them, 8 neonates were on mechanical ventilator in Neonatal Intensive Care Unit (NICU), with the evidence of persistent atelectasis clinically and radiologically. The indications of bronchoscopy in the rest 10 spontaneously breathing neonates were stridor in 6 cases and pneumonia in 4 neonates. Patient characteristics including age, gender and pre bronchoscopy presentations, route of bronchoscope insertion, findings of bronchoscopy and Broncho-alveolar lavage (BAL) analysis, complications during and after procedure and outcome were analyzed.

**Result:** Congenital abnormalities were seen in 7 (38.9%) neonates. Among them laryngomalacia was found in 3 neonates as the most common anomaly, followed by laryngeal web in 1, tracheomalacia in 1, tracheo-bronchomalacia in 1 and tracheal stenosis in 1 neonate. Inflamed bronchus was noted in 9 (50%) cases. Purulent excessive secretion was found in 7 (38.9%) neonates. BAL demonstrated microbiological yield in 7 (38.9%) neonates including 2 Multi Drug Resistant (MDR) organisms. Out of total cases of atelectasis, blood clot was detected in 1 case and thick mucus plug was found in 7 neonates in different parts of the airway. Mucus plug was removed by normal saline wash and blood clot was removed by dormia basket. Radiological and clinical improvement of atelectasis was detected just after therapeutic bronchoscopy. All neonates were extubated and weaned from mechanical ventilation within 24 hours (Mean 14 hours). Death or severe complications during or after bronchoscopy did not occur to any neonate.

**Conclusion:** Our results suggest that flexible bronchoscopy is very helpful and safe procedure for keen understanding and management of respiratory disorders in neonatal period, particularly in mechanically ventilated neonates having persistent atelectasis.

**Keywords:** Flexible Bronchoscopy; Neonate; Respiratory Problems

### Abbreviations

NICU: Neonatal Intensive Care Unit; BAL: Broncho-Alveolar Lavage; MDR: Multi Drug Resistant

### Introduction

Direct visualization of airway by bronchoscope has been established as a useful diagnostic and therapeutic modality in advanced respiratory care [1]. Over the last few decades, in adult ICUs, the number of these procedures have greatly increased, with both diagnostic and

therapeutic objectives [2,3]. The rigid bronchoscope is a metallic hollow structure and can be passed through the airway under general anesthesia and the flexible bronchoscopy is made of fiber optic technology having the ability to flex and extend with fine illumination. In the year of 1968, flexible bronchoscopy was introduced by Ikeda [4].

In 1978, the flexible fiber optic bronchoscope was first introduced as a real revolution in the management of respiratory diseases in paediatric age group [5] and subsequently, the flexible bronchoscopy has been used widely as both diagnostic and therapeutic tool in children [5,6].

Now-a-days, flexible bronchoscopy is a well-established tool for the evaluation of airway in pediatric patients and has been demonstrated to have a favourable safety profile in both the ambulatory and intensive care setting [7].

In neonates, the aims of flexible bronchoscopy are nearly the same as in older children but there are a number of special problems in neonates like congenital malformations, malacias of airway and mechanical complications of assisted ventilation. Again, persistent lung atelectasis, localized hyperinflation and acute respiratory failure are common events in neonatal intensive care unit (NICU), which are the well-established indications for urgent bronchoscopy [8].

Due to the small internal diameter of the airways and/or of the endotracheal tube of neonate, ultrathin flexible bronchoscopes have been developed [9,10], but bronchoscopy in this age group carries some risk of complications such as desaturation, airway trauma and laryngeal spasm [6,11]. However, there is also limited information about the safety and efficiency of bronchoscopy in NICUs [12,13]. On the other hand, there are several gaps in our knowledge to help refine its use and reduce its complications [14]. So, subsequently further studies are warranted.

We analyzed 18 procedures of flexible bronchoscopy in 18 neonates (both ambulatory and intubated mechanically ventilated). This study describes our experiences about utility and safety profile with a thin (Olympus 2.8 mm outer diameter) flexible bronchoscope in assessment and management of respiratory problems in neonate.

## Materials and Methods

### Subjects

A total 18 neonates who underwent bronchoscopy over a period of 16 months in a tertiary care hospital in Bangladesh, were reviewed retrospectively. Among them, 8 neonates (44.4%) were on mechanical ventilation in NICU having persistent atelectasis clinically and radiologically and bronchoscopy was done for therapeutic purpose. Out of the rest 10 (55.6%) neonates, 6 have stridor and 4 were diagnosed as pneumonia. In all these 10 spontaneously breathing neonates, bronchoscopy was done for diagnostic purposes (upper and lower airway anomalies, pathogen isolations). Patient characteristics, including age, gender and pre bronchoscopy presentations, route of bronchoscope insertion, bronchoscopic and Broncho-alveolar lavage (BAL) findings, complications and immediate outcome were analyzed. Informed written consent was obtained from all patients' parents.

### Bronchoscopy procedure

All neonates underwent bronchoscopy by thin (Outer diameter 2.8 mm with 1.2 mm action Channel, Olympus CLV-190 HQ) flexible bronchoscope. In total 10 spontaneously breathing neonates, fentanyl (1 - 3 mcg/kg) and midazolam (0.05 - 0.1 mg/kg) were given for analgesia and sedation. Topical anesthesia 2% lidocaine jelly for the nose and 1% lidocaine spray was administered over pharynx and larynx during bronchoscopy and bronchoscope was inserted through nasal route in these 10 neonates.

In total 8 neonates, who were on mechanical ventilation, only topical anesthesia with 1% lignocaine was administered and bronchoscope was inserted via endotracheal tube. The diameters of the endotracheal tubes were 3 mm, 3.5 mm and 4 mm in 2, 4 and 2 neonates respectively. The flexible bronchoscope was passed through a swivel Y connector located between the endotracheal tube and the ventilator. The connector allowed the introduction of bronchoscope into the endotracheal tube with uninterrupted mechanical ventilation and oxygen delivery.

BAL with normal saline (1 ml/kg in each time, maximum total 3 times) was taken and microbiological analysis was done in all cases. Heart rate and arterial oxygen saturation were continuously monitored during the procedure. The bronchoscope was withdrawn if the saturation fell < 90% and was re-inserted after recovery.

## Results

### Patient characteristics

Out of total 18 neonates, males were 12 and females were 6 with a ratio of 2:1. Age ranged from 8 day to 28 days with a mean  $\pm$  SD of  $19 \pm 2.1$  days and the weight of the neonates ranged from 2.1 kg to 4 kg with a mean  $\pm$  SD of  $2.4 \pm 0.6$  kg, as shown in table 1.

	Patients (n = 18)
Male	12 (66.7%)
Female	6 (33.3%)
Male: Female ratio	2:1
Age	Range: 8 days - 28 days Mean $\pm$ SD: $19 \pm 2.1$ days
Weight	Range: 2.1 kg - 4 kg Mean $\pm$ SD: $2.4 \pm 0.6$ kg

**Table 1:** Characteristics of patients.

### Bronchoscopic findings

In 7 (38.9%) of total 18 cases, congenital abnormalities were seen. Among them the most common anomaly was laryngomalacia, which was found in 3 neonates. Other structural abnormalities were 1 laryngeal web, 1 tracheomalacia, 1 tracheo-bronchomalacia and 1 tracheal stenosis. Inflamed bronchus was noted in 9 (50%) cases. Purulent excessive secretion was found in 7 (38.9%) neonates (Shown in table 2).

Pre-bronchoscopy diagnosis	No of cases	Post- bronchoscopy diagnosis (no of cases)
Stridor	6	Laryngomalacia with inflamed bronchus (1) Laryngomalacia (2) Laryngeal web (1) Tracheo-bronchomalacia inflamed bronchus (1) Tracheomalacia with excessive purulent secretion with inflamed bronchus (1)
Persistent atelectasis	8	Mucus plug with inflamed bronchus with excessive purulent secretion (1) Mucus plug with inflamed bronchus (2) Mucus plug with excessive purulent secretion (2) Mucus plug (2) Blood clot (1)
Pneumonia	4	Tracheal stenosis with inflamed bronchus (1) Purulent excessive secretion with inflamed bronchus (2) Purulent excessive secretion (1)

**Table 2:** Pre and post bronchoscopy diagnosis.

Out of total cases having atelectasis, blood clot was detected in left main bronchus of an 11 days old neonate and thick mucus plug was found in 7 neonates in different parts of the airway (3 in right main bronchus, 2 in left main bronchus, 1 in left upper lobe bronchus and 1 in bronchus intermedius).

BAL demonstrated microbiological yield in 7 (38.9%) of 18 neonates. Bacteria were isolated in 6 cases, which included 3 with *Klebsiella pneumoniae*, 1 with *Escherichia coli* and 1 with *Acinetobacter*. Among them MDR bacteria were found in 2 neonates. *Candida albicans* was isolated in one case, as shown in table 3.

Classification	Name of Micro-organism	Number (n = 18)
Bacteria (n = 5, 27.8%)	<i>Klebsiella pneumonia</i>	3 (16.6%)
	<i>Escherichia coli</i> *	1 (5.6%)
	<i>Acinetobacter</i> *	1 (5.6%)
Fungus (n = 1, 5.6%)	<i>Candida albicans</i>	1 (5.6%)

**Table 3:** Summary of BAL study.

\*MDR stain.

### Bronchoscopic intervention and outcome

Mucus plug was removed by normal saline wash and blood clot was removed by dormia basket. Radiological and clinical improvement of atelectasis was detected just after therapeutic bronchoscopy and all neonates were extubated and weaned from mechanical ventilation within 24 hours (Mean 14 hours) of mucus plug or blood clot removal by bronchoscopy. Pneumonia was improved after giving appropriate antibiotics according to culture sensitivity reports of BAL fluid.

During procedure, transient hypoxemia developed in 2 (11.1%) neonates which was alleviated by temporary cessation of the procedure. No significant changes in ventilatory pressures were observed during the procedures in neonates under mechanical ventilator. No severe complications like hemorrhage, airway trauma, respiratory or cardiac arrest or death occurred during or after bronchoscopy to any neonate.

### Discussion

The present study analyzed the procedures of flexible bronchoscopy in a group of neonates. This study evaluated and summarized the safety and the diagnostic and therapeutic value of flexible bronchoscopy in both mechanically ventilated and spontaneously ventilating neonates having respiratory problems.

In our study, inflamed bronchus was noted in 9 (50%) cases as the most common finding of bronchoscopy in neonate which is correlate with the data of Tang, *et al.* [15], they found inflammation in 55.3% cases in their study.

The current study shows that, flexible bronchoscope identified congenital anatomical abnormalities of airway (e.g. laryngeal web, tracheal stenosis) and anomalies of airway dynamics (e.g. malacias) in neonates. Other studies [16,17] also revealed that congenital abnormality of airway is very difficult to diagnose by history, physical examination and imaging and bronchoscopy may be the only method for diagnosis and differentiate the type. Conversely, the correct diagnosis of airway anomalies is of paramount importance for management decisions and providing intervention [18].

We found, mucus plugging is the most common cause of atelectasis in neonates who were on mechanical ventilation in NICU. This findings are consistent with previous study [15]. Tang, *et al.* [15] also showed mucus plugging as the most common cause requiring bron-

choscopy in NICU, and according to them, it might be associated with pulmonary infection with excessive secretion, nervous system or muscle disorder, muscle relaxant, sedatives use in mechanical ventilation. The current study shows, radiological and clinical improvement in all atelectasis cases after therapeutic bronchoscopy and all neonates were extubated and weaned from mechanical ventilation within 24 hours of mucus plug or blood clot removal by flexible bronchoscopy. Other studies also proved the therapeutic utility in the management of atelectasis in NICUs and PICUs by flexible bronchoscope [15,17]. On the other hand, some studies have shown that bronchoscopic suction is easy, quick, and highly effective and does not provoke any epithelial changes in neonates and small infants [15,19].

In the present study, BAL demonstrated microbiological yield in 38.9% cases but Terkawi., *et al.* [20] found higher (50%) in their study and described pediatric bronchoscopy as a crucial diagnostic and therapeutic tool.

The current study did not find severe complications like hemorrhage, airway trauma, respiratory or cardiac arrest or death during or after bronchoscopy to any neonate. Contrary to the findings in our study, post-bronchoalveolar lavage fever was reported in some studies [21,22]. Some studies reported cough reflexes as a significant complication during procedure [14,23]. We did not find cough reflex likely because of sedation in spontaneously ventilating neonates in our study.

In the present study, transient hypoxemia developed in 2 (11.1%) neonates during procedure, which was alleviated by temporary cessation of the procedure. Terkawi., *et al.* [20] also found desaturation as the most common complications during bronchoscopy but they reported that, 24% of patients developed non-life-threatening complications in their study.

This study has some limitations including the retrospective design and small sample size. We therefore, recommend further studies with a large number of patients to address this concern more precisely and conclusively.

### Conclusion

Our results suggest that flexible bronchoscopy is very helpful and safe procedure for keen understanding and management of respiratory disorders in neonatal period, particularly in ventilated neonates.

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### Conflict of Interest

No financial interest or any conflict of interest exists.

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