Diagnosing Pediatric Tracheal Bronchus with Bronchomalacia by Flexible Bronchoscopy versus Virtual Bronchoscopy

Yung-Cheun Lin, MD1, Yu-Chang Lee, MD2, Chien-Yi Wu, MD1, Yu-Tsun Su, MD3
1Department of Pediatrics, E-DA Hospital/I-Shou University, Kaohsiung City, Taiwan
2Department of Diagnostic Radiology, E-DA Hospital/I-Shou University, Kaohsiung City, Taiwan
3Division of Pediatric Pulmonology, Department of Pediatrics, E-DA Hospital/I-Shou University, Kaohsiung City, Taiwan

Abstract
Tracheo-bronchial diseases are difficult to diagnose. While flexible bronchoscopy is often used for diagnosis, virtual bronchoscopy is increasingly being used to successfully detect trachea-bronchial lesions and post-stenotic airway conditions. Due to age differences in respiratory physiology, radiation tolerance, and disease spectrum, virtual bronchoscopy is more often used with adults than with children. This report is a case of right upper lobe emphysema and stenosis of the tracheal bronchus in a 2-year 4-month-old boy. While virtual bronchoscopy suggested a bronchial polyp, the final diagnosis of bronchomalacia leading to a narrowing at the tracheal bronchus orifice was made by flexible bronchoscopy. Flexible bronchoscopy and virtual bronchoscopy can both be successfully used to detect trachea-bronchial lesions in adults and children. (J Pediatr Resp Dis 2015;11:59-63)

INTRODUCTION
The detection of trachea-bronchial diseases is challenging. Many modalities, including flexible bronchoscopy (FB), rigid bronchoscopy, multi-detector computed tomography (MDCT),1 direct coronal computed tomograph,2-3 and virtual bronchoscopy (VB),4,5 to evaluate these diseases have been developed. Because it is non-invasive and can be used to evaluate the post-stenotic airway, VB is becoming more popular. It is a simulated and continuous imaging of the intra-luminal airway, thereby providing images of the area from the vocal cords to the segmental bronchi. The image is generated through MDCT data. There are also many reports on its important role in diagnosing airway diseases.4-6 However, because children are different from adults in terms of respiratory physiology, radiation tolerance, and disease spectrum, its use in pediatric cases is limited. Thus, there are very few pediatric VB case studies, most of which focus on aspirated foreign body.7-13

This report is a case of a 2-year 4-month boy with emphysema of the right upper lobe and narrowing of the tracheal bronchus at its orifice. The VB imaging suggested that the stenosis resulted from a bronchial polyp, while FB later revealed bronchomalacia. This study demonstrates that FB may still be the gold-standard for evaluating airway diseases in children.
CASE REPORT

A 2-year 4-month old boy born prematurely (33 weeks age of gestation; birth body weight, 1920gm) had respiratory distress syndrome (Grade II) without surfactant treatment at birth. He was intubated for two days, but his hospitalization was uneventful and he was discharged at 30 days old. In the next two years, the patient had several episodes of wheezing during respiratory tract infections.

The patient was admitted to a regional hospital where he presented tachypnea with bilateral wheezing of more than one week. Chest x-rays revealed emphysematous changes of the right upper lobe. To evaluate his airway condition, MRCT and VB were performed, both of which revealed stenosis of the tracheal bronchus, probably due to a focal nodular protrusion. Bronchial polyp was the impression (Figs. 1 and 2). External compression such as vascular ring and tumor-like lesions were not demonstrated. The patient was transferred to a university-affiliated regional hospital for FB examination.

The FB demonstrated bronchomalacia at the orifice of the tracheal bronchus, with specific dynamic collapse during expiration and patency during inspiration (Fig. 3). The final diagnosis was congenital lobar emphysema of the right upper lobe associated with a tracheal bronchus and bronchomalacia. The patient was treated conservatively and remained well over the next 18 months.

Figure 1.
Chest computed tomography demonstrated stenosis at the orifice of tracheal bronchus (arrow)

Figure 2.
(A): Virtual bronchoscopy revealed narrowing and a bronchial polyp at the orifice of tracheal bronchus. Middle arrow: carina, Large arrow: left main bronchus, Small arrow: tracheal bronchus. (B) CT revealed right upper lobe emphysema and stenosis of tracheal bronchus at its orifice.
DISCUSSION

For this case of pediatric right upper lobe emphysema, the airway condition was evaluated before the treatment strategy was selected. While VB suggested a bronchial polyp, the FB findings suggested bronchomalacia leading to the narrowing of the tracheal bronchus at the orifice. The diagnosis was lobar emphysema resulting from a tracheal bronchus with bronchomalacia and the patient received successful conservative treatment.

Flexible bronchoscopy can be used to diagnose airway diseases by direct observation, endoluminal biopsy, and broncho-alveolar lavage. In 1984, Dr. Wood reported the results of the first large study on the use of FB for diagnosing pediatric airway diseases. That study reported a low complication rate and few relative contraindications, including severe airway narrowing, a bleeding tendency, and severe impairment of cardio-pulmonary function. Since then, FB had become the gold-standard modality for detecting trachea-bronchial airway diseases.

Virtual bronchoscopy (VB), a continuous imaging ranging from the vocal cords to the segmental bronchi, is generated from automated reconstruction MDCT data. The MDCT, began in 1992 with the development of multiple-section-capable scanners, makes it possible to obtain a volumetric dataset of the whole large airway simultaneously in a single breath held for less than 10 seconds. The MDCT shortens the examination time, decreases motion artifacts, and improves imaging quality. It is usually performed at end-inspiration. In case of suspicious dynamic airway collapse, the data at end-expiration is needed for information.

For adults, VB is a non-invasive tool used to evaluate the trachea-bronchial tree in cooperative patients. Compared to realistic bronchoscopy, VB has much less bleeding, obstructive hypoxia, and pneumothorax. It can be used to evaluate airway anomalies, detect post-stenotic lesions, and supply helpful information prior to conventional bronchoscopic or surgical intervention. It is superior to flexible bronchoscopy in revealing high-grade stenosis and visualizing post-stenotic area. Its sensitivity and specificity for detecting endobronchial lesions are reported to be 68% and 90%, respectively. While it is more useful for detecting lobar lesions (76% sensitivity) than segmental lesions (48% sensitivity), false-positive findings can result from retained secretions and artifacts. Although it allows for astonishing imitations of the airways, it is limited by artificial color representation.
Concomitant interventions are impossible. It is also not sufficiently accurate to detect endobronchial lesions in adults, especially in cases suspicious of malignancy.

The VB plays a limited role in children, too. The pediatric airway is smaller and easier to collapse. Thus, it is also easy to present as obstructive symptoms with airway edema or mucus. Infants and younger children cannot cooperate and hold their breath well during examination, resulting in poorer image quality and more artifact problems.

Sedation is usually necessary but if the attending physician cannot be bedside, CT is more risky when used on children than on adults. Another disadvantage of MDCT use in children is radiation exposure, especially since infants and children are more susceptible to radiation injury than adults. If CT is necessary for children, a lower radiation dose is strongly suggested. Although MDCT VB can be performed on children using 25-50 mA tube currents without IV contrast, it may be used only for evaluating aspirated foreign body in the airways. This radiation dose is one-third of that used in a typical child protocol (100 mA). In short, the sedation risk, possibility of misdiagnosis, and intolerance to radiation prevent the use of VB on pediatric cases.

The spectrum of trachea-bronchial diseases in children also differs from that in adults. In adults, trachea-bronchial lesions are usually endoluminal malignancies associated with airway stenosis due to compression, traumatic tracheal injury, and bronchial granulation following lung transplantation. In children, airway diseases result from a number of extrinsic and intrinsic conditions, including fixed or dynamic lesions. They are mostly congenital and less inflammatory, infectious, traumatic, or neoplastic. Boogaard et al., studying the results of 512 pediatric flexible bronchoscopies, reported airway malacia in 160 children (31.3%), 85% of whom had primary airway malacia and 15% secondary. Masters et al, studying 885 pediatric flexible bronchoscopies, found 299 cases (34%) with malacia disorder from the larynx to the bronchus. The major airway problem in pediatrics is airway malacia, which is usually diagnosed by FB because clinical diagnosis based on unspecific respiratory presentations is difficult to make. The MDCT is usually performed at end-inspiration with breath held, which may lead to an underestimation of the stenosis and malacia of the trachea-bronchial tree. Another purpose of MDCT is to rule out the possibility of external compression such as vascular ring and tumor-like lesions.

Virtual bronchoscopy is used mainly to diagnose foreign body aspiration in children. Cevizci et al., studying 38 pediatric patients with a suspicion of foreign body aspiration by VB, found 33 cases involving foreign bodies and five cases not involving a foreign body after rigid bronchoscopy examination. Among the five, two had bronchial vegetations, two obstructing mucus plug, and one external bronchial compression by neuroenteric cyst. There is a high possibility of misdiagnosis with the use of VB. Sodhi et al. compared MDCT-VB and bronchoscopy/surgery in 43 children with clinically suspected bronchial obstruction. Although MDCT-VB is well correlated to bronchoscopy/surgery, it is limited in disclosing the exact nature of obstructing pathology.

To date, FB is the only method of directly observing airway diseases in children. It can be used to diagnose airway diseases by direct observation, endoluminal biopsy, and broncho-alveolar lavage, as well as to resolve problems as it can be used to extract foreign bodies, implant stents, and perforate the web. The FB can also be successfully used as an initial therapeutic procedure for removing a foreign body in 21 out of the 23 children with foreign body aspiration. Thus, FB is not only a major tool for diagnosis of foreign body but is also a means of removing foreign bodies in infants and children.

In conclusion, virtual bronchoscopy is often effectively used in adults but not for children. Flexible bronchoscopy directly evaluates the dynamic airway and performs concomitant interventions. For pediatrics cases, FB may still be the gold standard for detecting trachea-bronchial diseases like dynamic trachea-bronchomalacia.

REFERENCES
2. Wong KS, Wang CR, Hsieh KH. Demonstration of tracheal bronchus associated with tracheal stenosis...


