Anomalous Bronchial Anatomy Complicating One-Lung Ventilation for Anterior Correction of Adolescent Idiopathic Scoliosis

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The standard protocol for placing anterior instrumentation to correct adolescent idiopathic scoliosis often requires 1-lung ventilation, which can be accomplished by using a double-lumen endotracheal tube to deflate the other lung or by using a bronchial blocker with a single-lumen endotracheal tube to block air from going through selected tracheal passageways.

We report the case of a patient whose trifurcation at the carina made placement of a double-lumen endotracheal tube technically challenging. After multiple failed attempts at placement, the surgery was aborted. One week later, a bronchial blocker was placed, and surgery was performed.

Case Report

A 10-year-old girl was diagnosed with adolescent idiopathic scoliosis (AIS) by her pediatrician at a well-check visit. The patient was asymptomatic at the time and presented with no other medical complaints. She had no history of medical problems, no prior surgery, and no history of back or leg pain. There was no family history of scoliosis. She was not using any medications. She was in good physical shape and an avid soccer player.

Radiographs showed a right-side 28° thoracic curve and a left-side 12° lumbar curve. The patient was initially placed into a Minnesota brace, but by age 12 her right-side T5–T12 curve had progressed to 54° and the left-side T12–L4 curve to 35°. Surgery intervention was recommended.

On presurgical physical examination, the patient stood with her right shoulder higher than the left and her pelvis level. She had a right thoracic curve with a 16° rotational component and a left thoracolumbar curve with a 6° rotational component. Her spine was fairly supple to side bending. She had no motor or sensory deficits, and her legs were of equal length.

An anterior thoracoscopic endoscopic approach was proposed because anterior release and fusion may prevent the crankshaft phenomenon in skeletally immature patients[1] and because fewer fusion levels are required for an anterior approach than for a posterior approach (the patient's spine could be classified King type I, main thoracic, or given a score of 1BN according to the classification system described by Lenke and colleagues[2]).

At surgery, with the patient in the left lateral decubitus position, an attempt was made to place a double-lumen endotracheal tube (DLT) so that the right lung could be collapsed. During the attempted intubation, a congenital variation in the tracheal anatomy was noted. The left upper lobe bronchus had an usually high take-off at the level of the carina (Figure 1). The opening of the tracheal tube portion of the DLT was therefore below the orifice of the left upper lobe bronchus, resulting in unintended occlusion of the left upper lobe bronchus (Figure 2). This resulted in collapse of both the entire right lung and the upper lobe of the left lung, which caused the patient to desaturate. Selective bronchial intubation was also technically prohibitive because of the patient's airway anatomy.

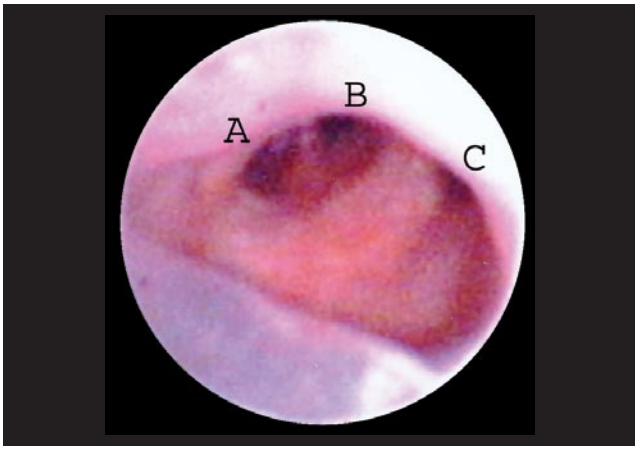

Figure 1. Bronchoscopic image shows (A) abnormally high left upper lobe bronchus taking off at carina level with left (B) and right (C) main-stem bronchi.

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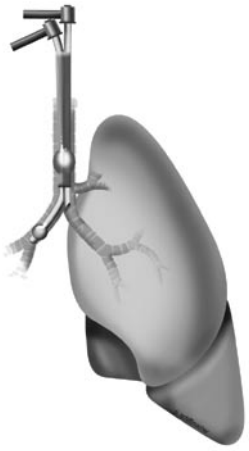

Figure 2. Double-lumen endotracheal tube separates right and left pulmonary units. Bronchial tube is inserted into right main-stem bronchus, and tracheal tube stops in main trachea, which effectively isolates ventilation. In this patient's case, however, the left upper lobe bronchus was unusually high, branching off at carina level, which caused deflation of left upper lobe plus entire right lung on ventilation through tracheal tube.

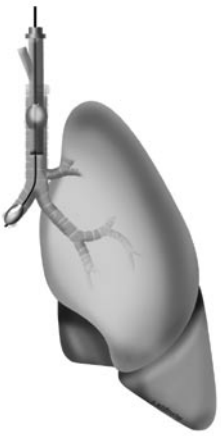

Figure 3. Insertion of bronchial blocker (BB) into right main-stem bronchus is our alternative method for achieving adequate ventilation. The BB is like a catheter with a balloon at the end of it. No air flows through the BB itself. Ventilation through single-lumen endotracheal tube allows air to reach entire left lung, regardless of aberrant tracheal anatomy.

Multiple attempts to replace the DLT, by both an anesthesiologist and a pediatric pulmonologist, were unsuccessful, and the surgery was aborted and rescheduled for 1 week later. At the next surgery, an alternative method for providing 1-lung ventilation was explored. A bronchial blocker (BB) was used to occlude the right main-stem bronchus and selectively deflate the right lung (Figure 3). There was little difficulty, the surgery was successfully executed, and the patient had an uneventful recovery.

Discussion

Safe and dependable selective ventilation of the lungs is essential during anterior thoracic spine surgery. In adults, this is readily accomplished through use of a DLT or through use of a BB with a single-lumen endotracheal tube (SLT).

The DLT and the BB function differently. The DLT isolates ventilation, separating the right and left pulmonary units using 2 separate endotracheal tubes (a bronchial tube and a tracheal tube), each with its own cuff (Figure 2). The BB, which blocks ventilation to a pulmonary segment, is a balloon-tipped catheter that is placed in the to-be-blocked portion of the trachea, usually the right or left main-stem bronchus. Ventilation to the pulmonary unit is blocked when the balloon is inflated (Figure 3).

Although the DLT is considered the method of choice for 1-lung ventilation, insertion can be technically challenging because of the size of its outer diameter (larger than that of BB plus SLT). The DLT is also more rigid (vs BB plus SLT), which makes maneuvering into atypical airway passages somewhat difficult.[3,4] The DLT tends to occlude the left upper lobe tracheal orifice, resulting in unacceptable hypoxia during 1-lung ventilation; unfortunately, this is what occurred with our patient.[5] Choosing a DLT of an appropriate size is also complicated by there not being any written guidelines for tube selection based on patient size, habitus, or chest radiograph findings. As a result, the DLT may not be the best option for selective intubation in a child with an aberrant air passageway.[4,5]

A BB with an SLT, on the other hand, is well suited in cases of altered upper airway anatomy, which is often seen in patients with scoliosis, as in our patient's case. A BB may be accurately placed through an SLT and directed into position using a fiberscope.[6]

We recommend that patients with AIS be considered as potentially having difficult airways, so that awareness of airway problems can be raised and intubation alternatives such as BB can be prearranged for potential use during surgery. Although no investigators have reported a high incidence of abnormal tracheal anatomy in patients with AIS, it is commonly accepted that patients with AIS often manifest decreased ventilatory function and efficiency.[6,7] Although DLT intubation avoids the need for fiber-optic BB placement and takes less time than BB placement with an SLT, we submit that a BB be available in the setting of pediatric anterior scoliosis surgery to avoid delays in successful airway management, as witnessed in this case report.[8]

Authors' Disclosure Statement and Acknowledgments

The authors report no actual or potential conflict of interest in relation to this article.

Our patient was notified that data concerning her case would be submitted for publication.

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