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Case Report/ Olgu Sunumu

An Alternative Method for Hypoxemia in Pediatric Flexible Bronchoscopy Procedure

Pediatrik Fleksible Bronkoskopi İşleminde Hipoksemiye Yönelik Alternatif Bir Çözüm Yöntemi

Oya Olcay Özdeş[1], Ömer Faruk Bilin[2], Aytaç Altaş[3], Zekine Begeç[3]

1 Battalgazi State Hospital, Department of Anesthesiology and Reanimation, Malatya, Turkey
2 Muş State Hospital, Department of Anesthesiology and Reanimation, Muş, Turkey
3 İnönü University, Department of Anesthesiology and Reanimation, Malatya, Turkey

ABSTRACT

Pediatric flexible bronchoscopy (FB) continues to be widely used in the evaluation of airway and lung pathologies. The anesthesia management of flexible bronchoscopy is more complicated in neonates and infants than in adults. In this case, we aim to present an alternative method to facilitate the difficult bronchoscopy procedure in an infant. A 35-day-old infant with persistent atelectasis underwent a flexible bronchoscopy procedure for diagnosis and treatment. A three-way tap was used as an adapter between the airway and the suction cannula to prevent the rapid development of desaturation during the second bronchoscopy, after the first bronchoscopy procedure was interrupted due to the patient developing hypoxemia. The open direction of the three-way tap was switched to align with the aspiration cannula when aspiration was needed, while ventilation was continued at all other times, thereby reducing the time lost due to equipment changes. The most common complication of bronchoscopy is hypoxemia, and patients under two years of age are particularly prone to it. This is physiologically due to limited oxygen reserves and high oxygen consumption. As a result, hypoxemia during pediatric bronchoscopy is a challenging complication to manage, even for the most experienced anesthesiologists. Organized teamwork is essential in preventing complications through the selection of appropriate equipment and the shared use of the airway. With this three-way tap, the time to desaturation in pediatric patients can be prolonged, allowing for more time to successfully complete the bronchoscopy procedure. It serves as an alternative method in centers with limited equipment.

Keywords: Bronchoscopy, Pediatric anesthesia, Hypoxemia

ÖZET

Pediatrik fleksible bronkoskopi (FB) havayolu ve akciğer patolojilerinin değerlendirilmesinde günümüzde yaygın olarak kullanılmaya devam etmektedir. Yenidoğan ve infantlarda erişkinlere göre fleksible bronkoskopi işleminin anestezi yönetimi daha komplikedir. Biz de bu vakada bir infantta zorlu bronkoskopi işlemini kolaylaştıracak alternatif bir yöntem sunmayı amaçlıyoruz. Otuz beş günlük persistan atelektazisi olan bir infant hastada tanı ve tedavi için fleksible bronkoskopi işlemi uygulanmıştır. İlk yapılan bronkoskopi işleminin hastada hipoksemi gelişmesi sebebiyle yarıda kalması sonucunda ikinci kez yapılan bronkoskopide desatürasyonun hızla gelişmesini önlemeye yönelik olarak, üç yollu bir musluk, hava yolu ve aspirasyon kanülü arasında bir adaptör olarak kullanılmıştır. Üç yollu musluğun açık yönü aspirasyon ihtiyacı olduğunda aspirasyon kanülü yönüne çevrilerek diğer tüm zamanlarda ventilasyon devam ettirilerek ekipman değişimiyle oluşacak zaman kayıpları azaltılmış oldu. Bronkoskopi işleminin en sık gelişen komplikasyonu hipoksemidir ve özellikle iki yaş altı hastalar hipoksemiye daha yatkındır. Bu fizyolojik olarak oksijen rezervlerinin sınırlı, oksijen tüketimlerinin fazla olmasına bağlıdır. Bu nedenle pediatrik bronkoskopi esnasında gelişen hipoksemi en deneyimli anestezistler için bile yönetmesi zor bir komplikasyondur. Komplikasyonların önlenmesinde uygun ekipmanın seçimi ve hava yolunun ortak kullanımı nedeniyle organize bir ekip çalışması önemlidir. Üç yollu muslukla oluşturduğumuz bu yöntemle pediyatrik hasta grubunda desatürasyon gelişme süresi uzatılabilir ve bronkoskopi işlemi başarılı bir şekilde tamamlanması için zaman kazanılmış olur. Sınırlı ekipmanın olduğu merkezlerde alternatif bir yöntemdir.

Anahtar Kelimeler: Bronkoskopi, pediatrik anestezi, hipoksemi

Corresponding author: Oya Olcay Özdeş
Battalgazi State Hospital, Department of Anesthesiology and Reanimation, Malatya, Turkey
E-mail: oyayiilmaz@hotmail.com ORCID ID: orcid.org/0000-0002-5436-3654
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Introduction

Flexible bronchoscopy (FB) is an important tool used in both the diagnosis and treatment of airway pathologies in children, including infants and neonates. Although the indications for flexible bronchoscopy vary by age, the most common indication is the evaluation of upper or lower airway obstruction, often presenting with stridor or persistent wheezing. Other indications include radiologic abnormalities (atelectasis, recurrent pneumonia), chronic cough, therapeutic procedures, and special procedures such as bronchoalveolar lavage or biopsy (1, 2).

Bronchoscopy poses an additional challenge for anesthesiologists due to the shared use of the airway by the bronchoscope (3). The method of anesthesia varies between clinics, ranging from conscious sedation to general anesthesia. Although general anesthesia is advantageous in terms of the comfort it provides for both the child and the practitioner, it requires very close monitoring. Complications associated with the use of a shared airway, particularly arterial oxygen desaturation, depend on patient-related risk factors (such as age and laryngotracheal abnormalities), anesthetic procedures, the choice of endoscope size, and practitioner experience (1).

In this case report, we present a simple yet effective method to prevent wasted time during a flexible bronchoscopy performed for diagnosis and treatment in a 35-day-old infant, which could not be completed due to rapid arterial oxygen desaturation.

Case Report

The patient is a baby girl born at 33 weeks and 5 days, weighing 1550 g, by normal spontaneous vaginal delivery from the first pregnancy of a 30-year-old mother. She was diagnosed with esophageal atresia at an external center and was operated on at the 6th hour after birth. While the lung parenchyma appeared normal on the posteroanterior (PA) chest radiograph taken before the operation, right upper lobe atelectasis was found on the postoperative radiograph (Figure 1 and Figure 2). The patient was referred to our center on postnatal day 35 due to the need for bronchoscopy because of the progression of atelectasis during follow-up at an external center.

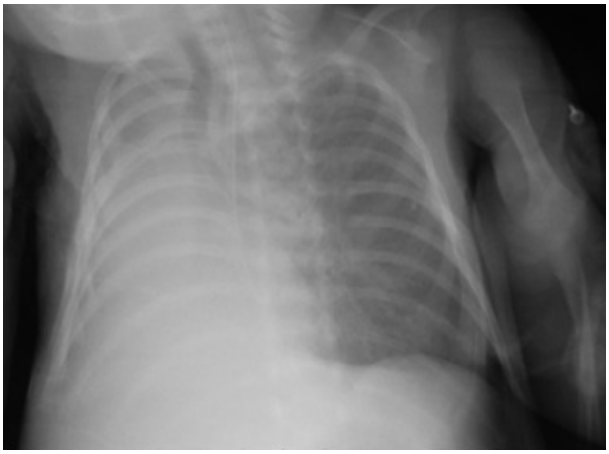


Figure 1 Preoperative posteroanterior chest radiograph



Figure 2 Postero-anterior chest radiograph on postoperative day 1

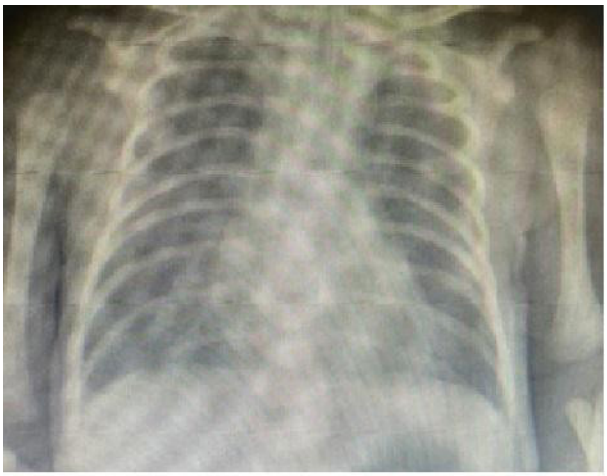


Figure 3 Postero-anterior chest radiograph on postnatal day 35

In our center, total atelectasis in the right lung was detected on the PA chest radiograph taken during the preoperative evaluation (Figure 3). The patient was

taken to the operating room for the first bronchoscopy by pediatric surgery, and standard hemodynamic monitoring was performed. Upon arrival, the patient was breathing spontaneously under 4 L/min O2 with a nasal cannula. The patient's heart rate was 128/min, blood pressure was 79/52 mm/hg, and oxygen saturation (SpO2) was 94%. Following adequate preoxygenation, anesthesia was induced with intravenous (I.V.) administration of 2.5 mg/kg of 1% propofol and 1 mcg/kg of fentanyl. After confirming that mask ventilation was not difficult, muscle relaxation was achieved with 0.9 mg/kg of rocuronium I.V. After adequate muscle relaxation, the patient was intubated uneventfully in a single attempt using a Miller blade No. 1 with a 3.5 mm ID cuffless endotracheal tube, which was sized to accommodate a flexible ureteroscopy (URS) endoscope prepared for use in bronchoscopy, and was tested before induction of anesthesia. Anesthesia was maintained with a mixture of O2 and air and 4% sevoflurane inhalation to achieve a MAC value of 1. The patient had to be intermittently weaned from the anesthesia machine so that the pediatric surgical team could perform flexible bronchoscopy through the endotracheal tube, but the procedure was discontinued to prevent any complications due to desaturation, which decreased from 96% to 60% in 15 seconds. In the first bronchoscopy, the right main bronchus was observed to be open, but its continuation could not be seen. After the procedure, respiratory distress and an atelectatic appearance on chest radiographs persisted, and a second bronchoscopy was planned. Three days after the first procedure, the patient was extubated and breathing spontaneously with a nasal cannula, and was taken back to the operating room. The entry vitals, anesthesia induction, and endotracheal tube size were similar to those of the first bronchoscopy procedure. An alternative method was developed to prevent rapid desaturation during the first procedure due to tube decommissioning, loss of time during the passage of the flexible bronchoscope through the tube, and insufficient oxygen insufflation during the bronchoscopy procedure, thereby providing sufficient time to perform the procedure. A three-way tap was attached to the aspiration port of the flexible

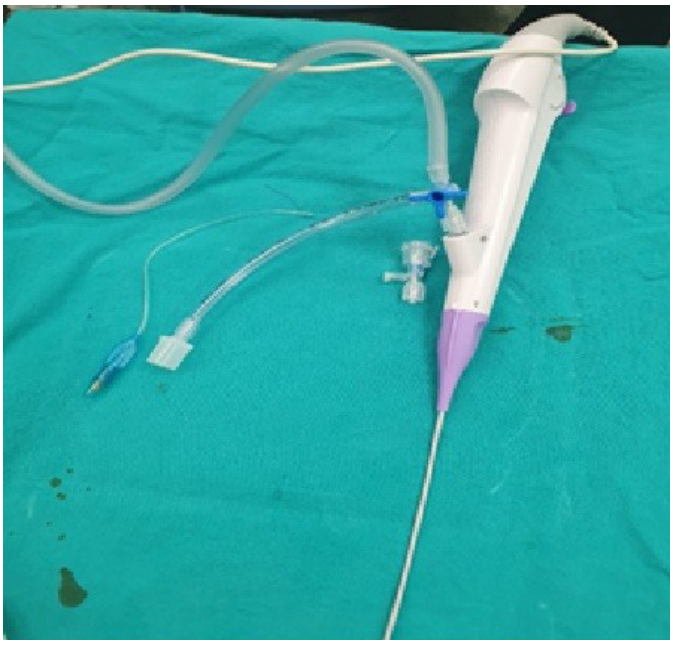


Figure 4 Three-way tap - suction cannula - number 6 endotracheal tube



Figure 5 In-process use of the three-way tap

bronchoscope. An aspiration cannula and endotracheal tube were inserted into the other ports of the three-way stopcock (Figure 4 and Figure 5). The endotracheal tube was selected as 6 mm ID because it was the most suitable size for the diameter of the three-way tap. At the beginning of the procedure, the patient's own 3.5 mm ID endotracheal tube was disconnected from the anesthesia machine circuit, and the circuit was connected to a 6 mm ID tube, which was then connected to the three-way tap. During the procedure, the open side of the three-way stopcock was turned toward the aspiration cannula side when necessary. At other times, it was turned toward the endotracheal tube side. Thus, the patient's oxygen flow continued during the bronchoscopy procedure, and the bronchoscopic intervention time evolved from 15 seconds in the first procedure to a desaturation-free period lasting 3-4 minutes (Table 1). This allowed bronchoscopy to be performed successfully. During bronchoscopy, the trachea and main bronchi were open. When the right main bronchus was entered, the bronchi of all three lobes were closed, with mucus plugs present in the lobar entrances. One and a half milliliters of surfactant was administered into the right main bronchus. Subsequently, a control examination was performed, and the bronchial mouths were found to be open. The patient was transferred to the neonatal intensive care unit as intubated.

Table 1. Comparison of two courses in bronchoscopy management

	1. Bronchoscopy procedure	2. Bronchoscopy procedure
Equipment	Flexible ureteroscope	Flexible ureteroscope + A three-way stopcock
Desaturation-free period	15 seconds	3-4 minutes
Clinical outcomes	Not completed	Completed

Discussion

The use of flexible bronchoscopy for both diagnosis and treatment in pediatric patients is quite common today. Complications during bronchoscopy include excessive coughing, mucosal bleeding and swelling, laryngospasm, bronchospasm, desaturation (hypoxemia) leading to bradycardia, unexpected or prolonged apnea, and pneumothorax (1). These complications are related to factors such as the patient, practitioner, selection of appropriately sized equipment, and anesthesia management. However, common complications are generally associated with anesthesia and ventilation (4). Although the rate of major complications is low, the complications that do occur are usually due to inadequate effective ventilation stemming from the general clinical condition of the patient and the consequent inability to provide the necessary oxygen support (5). In a retrospective study by Carlens (6) et al. of 670 elective bronchoscopies, hypoxemia was the most common complication during the procedure, and an age of less than two years, primary ciliary dyskinesia, and underlying cardiovascular disease were identified as independent risk factors for complications. In addition, in a retrospective analysis of 428 pediatric patients, it was determined that the most common side effect leading to the termination of the procedure was respiratory distress with severe desaturation. One case required intubation and monitoring in the intensive care unit for several hours (7).

Neonates and infants have small and fewer alveoli, which reduces lung compliance. The cartilage in their chest walls is very flexible. As a result of all these factors, their functional residual capacity is low, and their oxygen reserves are limited during periods of apnea. They have increased oxygen consumption compared to adults and are prone to atelectasis and hypoxemia. In addition, hypoxia and hypercapnia cause respiratory depression in contrast to adults because their respiratory drive is not fully developed. The fact that our case involved a 35-day-old infant who already had atelectasis presented challenging factors in our ventilatory management. The three-way tap we used to gain time, which allowed the patient to complete the procedure without hypoxemia, helped us overcome both physiologic and pathologic obstacles.

Intraoperative ventilation is a challenging task in patients undergoing bronchoscopy, as they are usually in borderline pulmonary condition. The goal is to provide satisfactory conditions for patient comfort and bronchoscopy while ensuring adequate gas exchange and hemodynamic stability (8). Therefore, the anesthesiologist managing the anesthesia and ventilation for the procedure should be a professional in pediatric anesthesia for all ages, including knowledge of respiratory and cardiovascular complications (1). In our case, anesthesia management was performed by an experienced pediatric anesthesiologist.

FB can be performed either under general anesthesia or deep sedo-analgesia, depending on case availability. The procedure, as well as airway management, can be performed transnasally, transorally, through a face mask, laryngeal mask, endotracheal tube, or tracheostomy cannula (8). Procedures performed without sedation include bronchoscopies with tracheostomy cannulas, supraglottic short airway examinations with topical anesthesia, and evaluations of swallowing disorders (1). In addition, dynamic airway assessments may require continued spontaneous breathing, or therapeutic procedures may necessitate longer periods of time that could cause the patient to desaturate (5). Artificial airway devices can bypass some structures, leading to missed or erroneous diagnoses (8). In light of this, we can say that the anesthesia and ventilation methods applied in the bronchoscopy procedure may vary according to the needs of the procedure and the available equipment (3). There are many studies in the literature using different airway equipment and anesthesia methods (9-11). In a study by Özaslan (2) et al. examining 410 pediatric flexible bronchoscopies, it was observed that airway safety was ensured with the use of a laryngeal mask, endotracheal intubation, and tracheostomy cannula according to the clinical condition of the patients. Laryngeal mask airway placement can be difficult in some patients due to anatomical changes. The patient in our case report is a premature neonate who underwent surgery for esophageal atresia and subsequently developed pulmonary pathologies. Since the mask not being stable in the correct position would increase time losses during the procedure for our hypoxemic patient, we preferred endotracheal intubation in this case. In addition, various equipment can be used to overcome difficulties related to the shared airway. For example, an adapter such as the Rusch Mainz adapter, placed between the supraglottic airway and the anesthetic breathing circuit, provides a conduit for both FB and ventilation (9). In this case, in which we performed general anesthesia and endotracheal intubation, we used a three-way tap, a simple piece of easily available equipment, as an adapter to save time for the bronchoscopy procedure that could not be completed due to rapid desaturation.

One of the most critical issues is that the appropriate size bronchoscope is not available in all centers due to the narrow airways in neonates and infants. Available pediatric flexible bronchoscopes range in outer diameter (OD) sizes from 2.2 to 6.3 mm, and internal channel sizes range from 1.2 to 3.2 mm in diameter. Most pediatric clinics will benefit from having 2.7 or 2.8 mm OD bronchoscopes, as these are the smallest bronchoscopes with suction channels (8). Since the smallest size FB was not available in our center, a flexible video ureteroscope that can easily pass through a 3.5 mm ID tube was used instead. In a case series published by Shivinder (12) et al., a flexible ureteroscope with an outer diameter of 2.8 mm was successfully used as an alternative to bronchoscopy in both emergency and elective cases.

In conclusion, although flexible bronchoscopy is an essential examination tool for the respiratory system in pediatric patients, safe anesthetic management can be challenging due to the area of examination. Although a variety of anesthesia and airway techniques are available, the best course of action is to utilize all available equipment to optimize conditions. An easily accessible three-way tap apparatus is very useful in managing hypoxemia.

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