Flexible bronchoscopy in postoperative period in pediatric patients with congenital heart disease in a ICU☆

Broncoscopia flexible en pacientes postoperatorios de cardiopatías congénitas en UCI pediátrica

Dear Editor:

Flexible bronchoscopy (FB) is a technique with diagnostic and therapeutic applications that may be useful in patients with congenital heart admitted to the paediatric intensive care. Our aim was to describe the characteristics of patients that underwent FB, the indications for the procedure, its findings and associated complications.

We conducted a retrospective and descriptive analysis of 21 FB procedures performed in 15 cardiac patients in the paediatric intensive care unit of a tertiary care hospital between 2013 and 2019. The proportion of patients with heart defects that underwent FB was 1.9% of the total that underwent surgical correction. We reviewed the health records of the patients and collected data on demographic characteristics, heart disease, indications for FB, respiratory support, FB findings and complications.

Two patients underwent 2 FB procedures and 1 patient 5, the rest underwent a single procedure. Four patients (26.7%) died of causes not associated directly or indirectly with the procedure, while the overall in-hospital mortality after cardiac surgery in our centre was 3.6% in the same period.

Patients underwent FB at a median age of 18 months (2–35 months) with a median weight of 5870 g (3800—6600 g). The median age of patients that underwent cardiovascular surgery in the same period was 15 months (2–52 months) and the median weight was 8800 g (3800—16 000 g).

Table 1 summarises the modalities of respiratory support used during FB, with mechanical ventilation being most frequent (50%). Three patients received support with extracorporeal membrane oxygenation. The table also presents the indications for FB and the underlying diseases.

The most frequent findings of FB (Table 1) were left bronchial stenosis and malacia. Pathogens were isolated in 6 of the 8 bronchoalveolar lavage samples: *Stenotrophomonas maltophilia* in 2, methicillin-resistant *Staphylococcus aureus* in 1, *Pseudomonas aeruginosa* in 1 and *Klebsiella pneumoniae* in 1, in addition to a positive galactomannan antigen test in another patient (indicative of fungal infection).

In 9 procedures, a pulmonary toilet was performed to remove mucus plugs, and in 3, adrenaline was delivered to treat mild bleeding. Steroid therapy was indicated in 1 patient and positive airway pressure in another 3, with no change to management in any other patients (Table 1).

Transient complications developed in 2 procedures: mild bleeding in one, and desaturation in another that required intermittent withdrawal of the bronchoscope.

Congenital heart and airway diseases are interdependent conditions given their common embryonic origin.1 More than 3% of patients with congenital heart diseases[1] have associated airway malformations that may prolong disease, increase the risk of respiratory tract infections, be life-threatening and hinder recovery.

Magnetic resonance imaging[2,3] is a non-invasive technique considered useful for diagnosis of airway malformations, but it carries risks for patients who are haemodynamically unstable, especially those who require invasive ventilation, as was the case in 50% of the sample under study. Thus, bedside FB could be a better option. In 11 of the 21 procedures (52%), the findings of FB led to changes in management in the form of prescription of treatments not previously used or the use of FB itself for treatment purposes. In 7 of the 10 procedures that did not lead to changes in management, a watchful waiting approach was chosen because the findings included areas of malacia that, given the age of the patients, were expected to resolve with adequate development of the airway through natural growth and maturation without invasive intervention, which has since been corroborated by none of them requiring surgical intervention in the airway at a later time.

Flexible bronchoscopy is a useful and safe technique[2,4,5] for the dynamic assessment of the airway that also allows performance of pulmonary hygiene interventions, delivery of substances and obtention of bronchoalveolar lavage samples that may guide antibiotherapy during the procedure. Recurrent or persistent atelectasis is the most frequent indication for FB in these patients.

The spectrum of airway disorders in our sample was similar to those described in other studies[2]: extrinsic compression of the airway by cardiac or vascular structures are the most frequent cause of obstruction, in addition to obstruction due to mucous secretions.[6] The left main bronchus is involved most frequently due to its position relative to the left atrium and the homolateral pulmonary artery. Between 13% and 26% of vascular malformations, depending on the series,[2] cause compression of the bronchial tree. Another aspect to consider is the possible presence of subglottic and tracheal stenosis after surgery[5] secondary to prolonged intubation and inflammation.

The detection of these abnormalities is useful for patient management, as surgical correction or positive airway pressure may be considered in the case of extrinsic compression. On the other hand, in the case of malacia, positive airway pressure is the temporary treatment of choice, as the problem resolves with growth in nearly all patients.

There may be complications of FB,[4,7] in most cases associated with risk factors in the patient, such as bleeding, fever, desaturation, bronchospasm or pneumothorax. Most are mild and self-limited, and the incidence of complications in our case series was 10%, which was consistent with the previous literature.

On one hand, it is important to consider that patients with operated heart defects that undergo FB tend to weigh less and are usually younger than patients with operated

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Table 1 Characteristics of patients that underwent flexible bronchoscopy.

Patient, sex, age at FB	Heart defect	Indication	Type of procedure	Respiratory support	Findings	Recommended treatment	Mortality
1, F, 5 m	Hypoplastic RV	Upper airway obstruction	Diagnostic	Nasal prongs	Bilateral vocal cord paralysis	Conservative	No
2, M 4 y, 3 m	DORV	Difficult intubation	Diagnostic-therapeutic (intubation with FB)	CPAP	Laryngomalacia and subglottic oedema	Steroid therapy	No
3, M, 3 y, 7 m	PDA	Extubation failure	Diagnostic	CPAP	Extrinsic right bronchial stenosis, unilateral vocal cord paralysis and laryngomalacia	Conservative	No
4, M, 5 m	VSD	Stridor	Diagnostic	Nasal prongs	Laryngomalacia and laryngeal oedema	Conservative	No
5, F, 4 m	Tetralogy of Fallot, pulmonary valve agenesis, SPCA, pulmonary artery aneurism	Atelectasis	Diagnostic	MV	Intrinsic and extrinsic bronchial stenosis and mucus plug	Conservative	No
6, M, 3 y, 9 m	Hypoplastic mitral valve, DORV, CoA, D-TGA	Atelectasis	Diagnostic-therapeutic (airway hygiene)	MV	Bronchomalacia and extrinsic right bronchial stenosis	Conservative	Yes
3 y, 10 m		Atelectasis	Therapeutic (airway hygiene)	MV	Intrinsic left bronchial stenosis and mucus plug	Conservative	No
7, M, 9 m	AVSD	Respiratory distress	Diagnostic	MV	Tracheomalacia, supraglottic oedema and mucus plug	Conservative	No
2 y, 7 m		Stridor	Therapeutic (airway hygiene)	Nasal prongs	Pharyngo-laryngomalacia	Conservative	No
2 y, 9 m		Atelectasis	Therapeutic (airway hygiene)	MV	Intrinsic and extrinsic left bronchial, intrinsic right bronchial stenosis and mucus plug	Conservative	No
2 y, 9 m		Atelectasis	Therapeutic (airway hygiene)	MV	Intrinsic and extrinsic left bronchial stenosis, intrinsic right bronchial stenosis and mucus plug	Conservative	No
2 y, 10 m		Atelectasis	Therapeutic (airway hygiene)	MV	Intrinsic and extrinsic left bronchial stenosis, intrinsic right bronchial stenosis and mucus plug	Conservative	No

Table 1 (*Continued*)

Patient, sex, age at FB	Heart defect	Indication	Type of procedure	Respiratory support	Findings	Recommended treatment	Mortality
8, M, 6 m	AVSD	Atelectasis	Diagnostic-therapeutic (airway hygiene)	NIV	Tracheal bronchus and mucus plug	Conservative	No
9, F, 1 m	Tetralogy of Fallot, pulmonary valve agenesis, pulmonary artery aneurism	Atelectasis	Diagnostic	MV	Extrinsic left bronchial stenosis, extrinsic right bronchial stenosis and bronchomalacia	Positive airway pressure	Yes
1 m		Atelectasis	Diagnostic	MV	Extrinsic left bronchial stenosis, extrinsic right bronchial stenosis y bronchomalacia	Positive airway pressure	
10, F, 4 m	AVSD	Stridor	Diagnostic	Nasal prongs	Tracheo-bronchomalacia	Positive airway pressure	No
11, F, 1 m	AVSD, situs inversus, pulmonary atresia, anomalous pulmonary venous return	Extubation failure	Diagnostic	MV	Tracheomalacia and hypoplastic left bronchus	Conservative	Yes
12, M, 1 m	Tetralogy of Fallot	Extubation failure	Diagnostic	NIV	Tracheomalacia, mucus plug and glottic oedema	Conservative	Yes
13, M, 3 m	VSD, PDA	Respiratory distress	Diagnostic	NIV	Laryngomalacia and arytenoid oedema	Conservative	No
14, F, 1 m	D-TGA, CoA, PDA	Stridor	Diagnostic	Nasal prongs	Extrinsic supraglottic and left bronchial stenosis	Conservative	No
15, F, 6 m	AVSD, PDA	Stridor	Diagnostic	No support	Extrinsic left bronchial stenosis, laryngomalacia, glottic oedema	Conservative	No

AVSD, atrioventricular septal defect; CoA, coarctation of the aorta; CPAP, continuous positive airway pressure; DORV, double-outlet right ventricle; D-TGA: dextrotransposition of the great arteries; F, female; FB, flexible bronchoscopy; M, male; MV, mechanical ventilation; NIV, non-invasive ventilation; PDA, patent ductus arteriosus; RV, right ventricle; SPCA, systemic-to-pulmonary collateral artery; VSD, ventricular septal defect.
Age expressed in years (y), months (m).

heart defects that do not require this procedure. This, along with other comorbidities, could have played a role in the greater mortality observed in patients that underwent FB, and this procedure not have been the direct cause of the increase, as these patients were in poorer condition or had more severe disease at the time of surgical intervention.

The main limitations of the study, in addition to its retrospective design, are its small sample size, unavoidable given that it was conducted in a single centre, and few hospitals in Spain—to our knowledge—have published case series on the subject.

Thus, to conclude, we believe that FB may offer a high diagnostic and therapeutic yield in neonates and infants with surgically corrected congenital heart defects, and while considered an invasive technique and precisely on this account, its potential benefits and risk should be assessed on a case-by-case basis before its performance. Expert use of FB and its performance based on shared decision-making by intensive care physicians, cardiologists and bronchoscopy practitioners make this technique reasonably safe, but it is never without risk or a routine procedure. It is also important to remember potential complications, in which the underlying disease and condition of the patient at the time of the procedure play a significant role.

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Current perspectives in Ross and Ross–Konno procedures: Is it time to search for alternatives?☆,☆☆

Perspectivas actuales en el procedimiento de Ross y Ross–Konno: ¿es hora de buscar alternativas?

Dear Editor:

Congenital left ventricular outflow tract obstruction that is symptomatic or associated with ventricular dysfunction is an indication for surgery in the paediatric population. When the obstruction is at the level of the aortic valve, the Ross procedure (pulmonary autograft) is the approach of choice. When the obstruction is found at several levels, the gold standard is the Ross-Konno procedure (pulmonary autograft combined with ventriculoseptoplasty). Both techniques have shown to provide excellent haemodynamic outcomes and potential for growth.[1]

However, none of these alternatives can be considered a definitive solution when the problem arises in neonates or infants.[2,3] Outcomes in the medium to long term show a substantial number of reinterventions, both percutaneous and surgical. When both sides of the heart are involved, treatment becomes very complex.

A new possibility for these patients has recently emerged with the description of the Ozaki technique[4] (complete aortic valve reconstruction using pericardial tissue). To be able to make meaningful comparisons in the future, the outcomes of techniques currently in use need to be analysed first. For this reason, we report our experience in the last decade using the gold standard techniques.

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