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CASE REPORT

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Elective re-intubation to treat complete left lung collapse following Tetralogy of Fallot repair in a very young child

Nirmal Panthee[1] | **Battu Kumar Shrestha**[2] | **Sidhartha Pradhan**[1] | **Raamesh Koirala**[1] | **Bishow Pokhrel**[1] | **Abhishek Chaurasiya**[1] | **Amita Paudel**[1] | **Rumi KC**[1]

[1]Department of Cardiac Surgery, Shahid Gangalal National Heart Center, Kathmandu, Nepal

[2]Department of Anesthesiology, Shahid Gangalal National Heart Center, Kathmandu, Nepal

Correspondence
Nirmal Panthee, Department of Cardiac Surgery, Shahid Gangalal National Heart Center, Bansbari, Kathmandu, Nepal.
Email: nipanthee@gmail.com

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Abstract

An 18-month-old boy weighing 6 kilograms developed complete collapse of left lung following total correction of Tetralogy of Fallot on the next day of extubation. He received extensive chest physiotherapy, along with lung recruitment maneuver by using bubble CPAP, which failed to show any improvement in lung expansion in 2 days. He was then electively intubated on 3rd postoperative day (POD3) for the purpose of suctioning tracheobronchial secretions and maintaining positive airway pressure to open up the left lung. Good results were obtained immediately after intubation, and he was extubated 9 h later. His lung showed complete aeration afterward. He was transferred out of ICU on POD5 and discharged home on POD10.

KEYWORDS

cardiac surgery, endotracheal intubation, lung collapse, pediatrics

1 | INTRODUCTION

Lung collapse (atelectasis) is the most common pulmonary complication following cardiac surgery, and it is mainly attributed to the use of anesthetic drugs, narcotics, and no ventilation during cardiopulmonary bypass.[1] Sternotomy and the associated pain are reported to play important roles contributing to poor lung function following cardiac surgery.[1] It is important that we maintain patency of small airways and alveoli at all times no matter what the patient is on or off the ventilator. Lung collapse can result from obstruction of airways (e.g., mucus plug) or from compression of alveoli from outside (e.g., pneumothorax).[2] If obstruction is the likely cause of lung collapse, a number of techniques are utilized to treat collapse such as airway suctioning, postural drainage, use of vibrators, chest wall percussion, use of mucolytic agents, and fiberoptic bronchoscopy.[2,3] In small children, doing fiberoptic bronchoscopy is challenging and the facility is not readily available in every center. In such situations, elective intubation for the purpose of endotracheal suctioning and maintaining positive airway pressure is one viable option though it is more invasive.

2 | CASE REPORT

An 18-month-old boy was brought to us with shortness of breath during feeding and poor weight gain since birth. On examination, his vitals were stable. He did not have frank cyanosis, and clubbing, edema, and jugular venous distension were absent. Chest examination revealed bilateral

equal air entry with no added sounds. Cardiovascular examination revealed normal S1 and S2 with systolic murmur in precordium, with palpable thrill. His oxygen saturation (SpO2) was 85% in room air. Baseline blood examination was within normal limit except for elevated total count (16,000/mm^3; neutrophils 45%, lymphocytes 45%). ECG showed sinus rhythm with heart rate of 91 bpm and right ventricular hypertrophy. Chest X-ray showed cardiothoracic ratio (CTR) of 0.55 with slightly oligemic lung fields. Transthoracic echocardiography revealed normal left ventricular dimensions (1.7/1.2 cm) with ejection fraction (EF) 60%, thickened pulmonary valve, hypertrophied right ventricular infundibulum, combined (infundibular plus valvular) pulmonary stenosis (peak and mean pressure gradients of 81 mmHg and 55 mmHg, respectively), large ventricular septal defect with bidirectional shunt, and tiny patent ductus arteriosus (PDA). Overriding of aorta was 40%. Computed tomography (CT) scan revealed similar findings as echocardiography and further delineated a long segment narrowing of right ventricular outflow tract. With this, diagnosis of Tetralogy of Fallot (TOF) with PDA was made and he was planned for total correction of TOF and PDA ligation.

Total correction of TOF via transatrial transpulmonary approach with additional right ventricular outflow tract (RVOT) patch was done. Total cardiopulmonary bypass (CPB) time was 132 min, and aortic cross clamp time was 95 min (78+17 min). After initial declamping, right ventricular (RV) pressure was suprasystemic, so second time aortic cross clamp was applied and RVOT was augmented with pericardial patch, following which RV pressure decreased to 2/3rd of systemic pressure. Weaning from CPB was uneventful, and he was transferred to pediatric intensive care unit (PICU) on minimal inotropic support. He was extubated 2 h after arrival to PICU.

Chest X-ray (CXR) immediately after arrival to PICU looked normal (Figure 1A). CXR the next morning (POD1 AM) was also normal (Figure 1B). However, the evening CXR on POD1 showed complete collapse of left lung (Figure 1C). After viewing this CXR, bedside ultrasonography was done, which ruled out pleural effusion. Then, the kid was kept on bubble continuous positive airway pressure (CPAP) with the use of nasal cannula (Bubble CPAP circuit with heated wire; Medisafe International, Mukherjee Nagar, New Delhi, India), and aggressive physiotherapy of chest was done by percussion, postural changes, use of vibrator, and use of mucolytic agents. However, the collapsed lung did not expand till POD3 (Figure 1D,E). At that point, decision to electively intubate for the purpose of endotracheal suctioning and maintaining positive pressure was made. So, on POD3 at 11PM, the kid was electively intubated. Immediately after intubation and endotracheal suctioning, the CXR showed marked improvement (Figure 1F). He was extubated early next morning (POD4 at 8AM) 9 h later after intubation. Left lung remained expanded throughout then after (Figure 1G,H). He was transferred to general ward on POD5 and discharged home on POD10, with no other complications.

3 | DISCUSSION

Postoperative lung collapse following any kind of surgery under anesthesia is a common phenomenon. In cases of cardiac surgery, the risk is even higher because of the use of cardiopulmonary bypass. During cardiopulmonary bypass, the lungs are not ventilated leading to collapse of small airways and alveoli. Recruiting the lungs by manual ventilation and use of positive end expiratory pressure (PEEP) at the end of cardiopulmonary bypass and before transfer to the ICU results into lung expansion. While on ventilator, use of PEEP and use of minimal inspired oxygen concentration (FiO2), regular endotracheal suctioning, and chest physiotherapy protect the lungs from collapse. After extubation, aggressive chest physiotherapy is the only way to prevent and treat lung collapse.

The deep breathing exercises routinely prescribed after cardiac surgery have shown positive effects on atelectasis, lung volumes, oxygenation, and dyspnea.[4] However, these are of limited use in children due to poor patient compliance. Noninvasive ventilation (bilevel positive airway pressure (BiPAP) or bubble CPAP) are utilized to give positive pressure with hopes of reversing atelectasis. While BiPAP is usually applied in adult patients with the use of tight facemask, bubble CPAP utilized in children uses nasal cannula; therefore, maintaining airtight space is always difficult; thereby making it less effective as opposed to BiPAP utilized in adults. Use of BiPAP using facemask in children is very difficult because of the poor compliance. In our case, we utilized bubble CPAP for 2 days prior to the decision to reintubate the child.

Functional residual capacity (FRC), also called resting lung volume, is reduced during anesthesia promoting airway closure and atelectasis. Airway closure and subsequent atelectasis will be prevented if FRC is restored, which is achieved by application of PEEP and by lung recruitment maneuvers in intubated patients.[5] The same is not true in extubated patients because patients are self-breathing. So, we had to reintubate the patient so that we could apply PEEP and perform lung recruitment maneuvers as well as we could aspirate the endortacheal secretions by using suction catheter to remove mucus plug. Aspiration of mucus plug would simply have been achieved by the use of bronchoscopy. However, our center did not have pediatric-sized bronchoscope; so, this

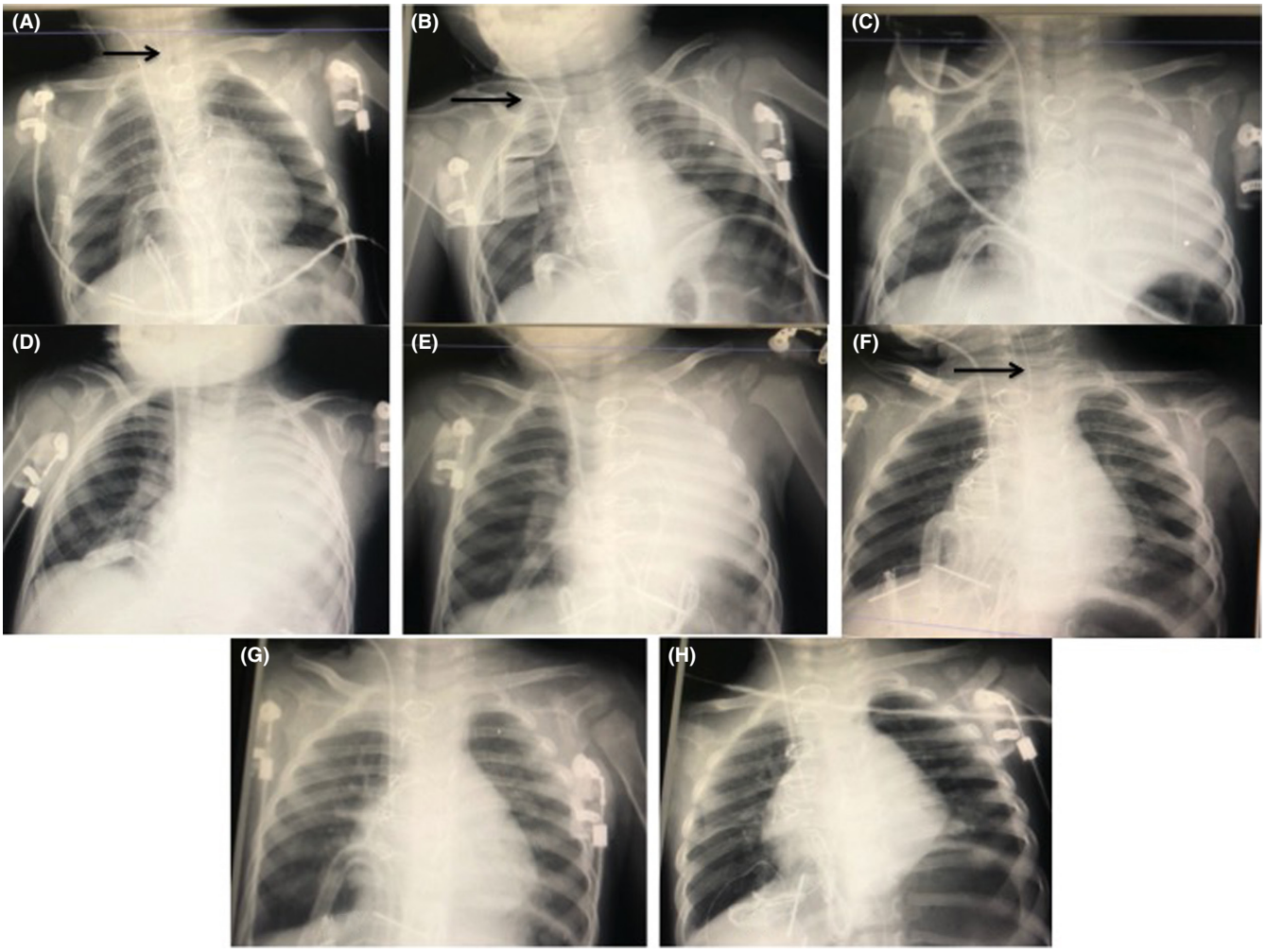

FIGURE 1 Chest X-ray antero-posterior views. (A) immediately after arrival to PICU (POD0) (please note well expanded bilateral lungs; arrow shows endotracheal tube in situ); (B) on the morning of POD1 (POD1; AM) (please note well expanded bilateral lungs; the kid is already extubated; arrow shows the artifact of facemask); (C) on the evening of POD1 (POD1; PM) (please note collapse of left lung; after viewing this X-ray, the patient was kept on bubble CPAP); (D) on POD2 (the left lung is still collapsed despite the child being kept on bubble CPAP); (E) on the evening of POD3 (the left lung is still collapsed despite the child being on bubble CPAP. After viewing this X-ray, we planned elective intubation); (F) on POD3 immediately after re-intubation (please note that left lung is now fully areated; arrow shows endotracheal tube in situ); (G) on POD4 after extubation (please note that left lung is now fully aerated; the child is already extubated); (H) on POD5 before transfer to the general ward (the left lung remains aerated). Abbreviations: PICU, pediatric intensive care unit; POD, postoperative day; and CPAP, continuous positive airway pressure

option was off table. Wherever possible, flexible bronchoscopy and aspiration should be the first intervention. Our team has accumulated large experience in pediatric intubations and management of ventilators. So, we felt confident to pursue this path although this method was much more invasive. Left lung showed complete expansion immediately after intubation, and we were able to extubate him early next morning (9 h after re-intubation). In our center, surgeon and anesthesiologist are available in-house 24 h; so, we decided to intubate in the middle of the night in hopes of early extubation next morning, although this is not the usual practice in many other centers.

Collapsed lung is considered as a locus for infection.[5] So, it is important that we intervene at the earliest to avoid poor outcomes in two fronts (oxygenation and infection). Even after waiting for 2 days (48 h) with the use of bubble CPAP, the left lung did not show any improvement, at which point we decided to intervene. Interestingly, our child had normal SpO2, PO2, and PCO2 levels throughout the entire course even with the white-out left lung.

This kind of report is not so common in literature because most of the advanced centers who do pediatric cardiac surgery also have availability of pediatric bronchoscopy. We believe, our report would help those centers

who do not have readily available pediatric bronchoscopy in pediatric intensive care units.

4 | CONCLUSION

Lung collapse is not so uncommon following pediatric cardiac surgery. Chest physiotherapy is almost universally utilized to treat lung collapse. If the physiotherapy fails to expand the lungs and there is no facility for pediatric flexible bronchoscopy, brief elective intubation can treat the lung collapse in experienced hands.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest.

AUTHOR CONTRIBUTION

NP involved in concept, original manuscript draft, data collection, and management of the case. BKS, SP, RK, and BP involved in concept, revision of original draft, and management of the case. AC, AP, and RKC involved in revision of original draft, data collection, and management of the case.

ETHICAL APPROVAL

Written informed consent was obtained from the parents of the child for publication of this report.

CONSENT

Written informed consent was obtained from the parents of the child for publication of this report.

ORCID

Nirmal Panthee https://orcid.org/0000-0003-2254-5573

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