Use of a Fogarty balloon catheter to decompress pneumatocele in preterm neonates

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Abstract

Introduction

Unilateral or bilateral pneumatoceles are a known complication in preterm neonates with severe respiratory compromise who undergo mechanical ventilation for prolonged periods of time. These pneumatoceles often result in respiratory failure and are often a challenge to treat despite the use of different modes of ventilation and positional changes. Multiple case series in literature are selective in bronchial intubation as an effective mode to treat such pneumatoceles. We report two cases of selective bronchial occlusion to treat large pneumatoceles that were not responding to conservative approach and causing significant respiratory compromise in two extremely low-birthweight infants.

Case Report

We selectively occluded the unilateral mainstem bronchus of the affected side with a 5.5 French Fogarty balloon catheter, which resulted in the collapse of the large pneumatocele. After 48 h, the catheter was removed and the lungs were re-inflated, without reappearance of the pneumatocele. We, therefore, report the successful treatment of large, symptomatic pneumatoceles in extremely low-birthweight infants via bronchial occlusion using a Fogarty balloon catheter.

Conclusion

Further studies are needed to evaluate the safety and efficacy of such treatment.

Introduction

Air leak syndromes include pneumothorax, pneumomediastinum, pulmonary interstitial emphysema (PIE) and less commonly pneumatoceles. Pneumatoceles (also known as pulmonary pseudocysts) are thin-walled gas-filled cysts that develop within the lung parenchyma. Neonatal pneumatoceles have been described with ventilator-induced air-leak conditions mostly in the settings of RDS, pneumonia, bronchopulmonary dysplasia (BPD) and meconium aspiration syndrome (MAS). Neonatal pneumatoceles if large can cause significant respiratory compromise in preterm infants. Upon review of the literature, pneumatoceles in neonates have been treated using multiple strategies, including unilateral lung intubation1, surgical lung volume reduction2 and bronchial occlusion via Swan–Ganz catheter3,4. Each strategy has been associated with complications, and to date, there are no clinical trials suggesting one strategy being more efficacious than the other.

In this report, we describe the use of a 5.5 French Fogarty balloon catheter for selective bronchial occlusion in two ELBW preterm neonates with large, unilateral pneumatoceles that did not respond to conservative management with high-frequency ventilation using a low-pressure strategy. After discussing the proposed procedure with the parents, we extubated each infant, inserted the 5.5 French Fogarty balloon catheter through the vocal cords under direct visualisation via laryngoscope and then reintubated the infant. The length of insertion was calculated to be 1 cm more than the calculated endotracheal tube length based on the infant’s weight. Chest x-rays were taken to confirm balloon catheter placement in the mainstem bronchus of the affected side. After confirmation of position, the balloon was inflated with 0.3 to 0.5 cc of sterile saline.

Case Report

Case 1: Baby boy B was born to a 32-year-old female with di-di twin gestation from an IVF pregnancy at 24 weeks gestation. Pregnancy was complicated with preterm labour. Birthweight was 709 g and Apgars were 5 and 8 at 1 and 5 min respectively. The infant was intubated in the delivery room due to respiratory distress and developed worsening respiratory distress syndrome in the neonatal intensive care unit, requiring treatment with endotracheal surfactant and conventional mechanical ventilation. The infant had a progressive deterioration in his respiratory status and was switched to high-frequency oscillatory ventilation (HFOV) on day 3 of life. On day 4 of life, the infant was diagnosed with a symptomatic patent ductus arteriosus which was treated and closed with indomethacin. The infant had significant clinical deterioration on day 7 of life in the setting of a spontaneous intestinal perforation. On day 9 of life, a pneumatocele was first noted in the left lower lung field. HFOV settings at this time were a mean airway pressure of 10, amplitude of 28 and FiO₂ of 100% (Figure 1a). The following day, selective right mainstem

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Case report

II IVH on the left were noted. The infant remained on HFOV and high-frequency jet ventilation for PIE. On day 9 of life, a large right upper-lobe pneumatocele was noted as shown in Figure 2a. By day 15 of life, the pneumatocele had significantly enlarged and was causing mediastinal shift to the left. Due to severe respiratory failure, bronchial occlusion was discussed with the parents and was performed on day 22 of life. The pneumatocele was noted to be smaller within 48 h (Figure 2b) after insertion of the Fogarty balloon catheter. The balloon catheter was removed after 48 h and the pneumatocele had resolved (Figure 2c). There were no catheter-related complications in this case and the infant continued to improve and was subsequently extubated to non-invasive continuous positive pressure ventilation on day 47 of life.

Figure 1: (a) Large left-sided pneumatocele causing mediastinal shift. (b) Fogarty balloon catheter in left main bronchus with generalised atelectasis. (c) X-ray prior to removal of catheter with no visible pneumatocele.

Figure 2: (a) Large right-sided pneumatocele causing mediastinal shift. (b) Fogarty balloon catheter in right main bronchus causing decompression of pneumatocele. (c) X-ray after removal of Fogarty balloon catheter.

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Discussion
Pneumatoceles in newborns have mostly been described in the setting of barotrauma due to persistently high airway pressures in chronically ventilated preterm infants. A number of non-invasive and invasive approaches to treat or decompress pneumatoceles have been described in the literature. Lopez et al. describe a case of self-resolving pneumatocele, suggesting that intervention may not be required. However, it can be speculated that his approach may only be feasible in cases where the pneumatocele is not causing significant respiratory distress.

A non-invasive technique that is commonly practiced is to place the infant in a lateral decubitus position, with the affected side down and to maintain that position for an extended period of time. The assumption is that the weight of the mediastinal contents will gradually compress the dependent lung and subsequently decompress the pneumatocele. Cohen et al. suggested that serial chest radiographs should be obtained 48–72 h after complete collapse, before the infant is returned to the supine position. This approach is likely to be successful in early unilateral disease. One significant limitation, however, is that infant positioning can be difficult at times and especially in situations where the neonate may have a chest tube in place.

Invasive techniques include selective intubation of the main bronchus of the normal lung. When unilateral disease is present on the left, selective intubation of the right side may be easily performed by advancing the endotracheal tube into the right mainstem bronchus. Selective left mainstem intubation, however, is a technically difficult procedure and often requires fluoroscopic guidance. In such cases, selective obstruction of right mainstem bronchi may be preferred. This can be achieved by inserting an appropriately sized balloon tipped catheter (such as a Fogarty embolectomy catheter as we described above) and advancing it to the right mainstem bronchus. Visualisation and positioning of the balloon catheter can be aided by inflating the balloon with angiographic contrast.

Conclusion
In this report, we have described two preterm ELBW neonates who developed pneumatoceles which were resistant to conservative management on high-frequency ventilation. Pneumatoceles in both infants were successfully decompressed with unilateral lung ventilation using a Fogarty balloon catheter. While placement in the right mainstem bronchus can easily be accomplished, placement in the left mainstem bronchus may be more challenging, though we did not encounter any difficulties and had successful placement of the balloon catheter in the left mainstem bronchus on the first attempt. We therefore conclude that selective obstruction of the affected lung can be a promising intervention in a preterm infant with a large, symptomatic pneumatocele. However, clinicians must be cautious of the possible complications associated with selective bronchial obstruction and placement of balloon catheter. These complications include, but are not limited to, pneumothorax, trauma to the vocal cords during insertion, pneumonia, hypoxia, bradycardia and potential perforation of bronchial tree. Further studies assessing the safety and benefits of this procedure in preterm or term infants are needed before it can be generally recommended.

Consent
Written informed consent was obtained from the patients for publication of this case report and accompanying images. A copy of the written consent is available for review by the editor-in-chief of this journal.

Abbreviations list
BPD, bronchopulmonary dysplasia;
HFOV, high-frequency oscillatory ventilation;
MAS, meconium aspiration syndrome;
PFE, pulmonary interstitial emphysema.

References