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Life Threatening Bilateral Tension Pneumothorax Complicating Artificial Ventilation in an Infant with Severe RSV Bronchiolitis

YW ***Hui,*** WH ***Choy,*** KY ***Chan***

Abstract Acute bronchiolitis is a common cause for childhood hospitalisation and respiratory syncytial virus (RSV) is the most important cause of bronchiolitis during infancy. We report a case of life threatening bilateral tension pneumothorax complicating bronchiolitis in an infant. A 2-month-old infant girl suffered from respiratory failure due to severe RSV bronchiolitis. While on hand ventilation (hand bagging) through endotracheal tube in the Accident & Emergency Department, she developed cyanosis and bradycardia because of bilateral tension pneumothorax. She responded to cardiopulmonary resuscitation and tube thoracostomy. She was supported by mechanical ventilation with the strategy of permissive hypercapnia in paediatric intensive care unit (PICU). Her condition improved uneventfully and she recovered without long-term adverse sequelae.

Key words Bronchiolitis; Permissive hypercapnia; Respiratory syncytial virus; RSV; Tension pneumothorax

Case Report

A 2-month-old girl, who was well all along, presented with a 3-day history of fever and coryzal symptoms. She was treated by private doctors with dexchlorpheniramine, ephedrine nasal drops and cefaclor. Her condition was getting worse and developed shortness of breath with noisy breathing and became drowsy and cyanotic. In the Accident & Emergency Department (AED), she was found to be in severe respiratory distress with marked chest recession, and cyanosis. The initial vital signs were heart rate 134/min, respiratory rate 40 breaths/min and SaO_2 76%. Chest examination revealed poor air entry with occasional expiratory rhonchi. The liver edge was 2 cm below the right costal margin. Respiratory failure developed rapidly, prompting emergent intubation. An endotracheal tube of size 3.5 mm was inserted at a level of 11 cm at the lip. There was no foreign body found at the throat during intubation. She was supported with hand ventilation using Laerdal ambu bag. She improved and turned pink, but about 5 minutes later, she became cyanotic again despite continuous hand ventilation. The lung became very stiff to bagging and the heart rate dropped to 40/min, but the pulse was not palpated. The liver edge was 10 cm below the right costal margin. Cardiopulmonary resuscitation was initiated, and 3 doses of epinephrine were administered by intraosseous route. Tension pneumothorax was suspected and needle thoracostomy was performed and yielded 30 ml and 50 ml of air from left and right chest respectively. Her condition improved after the procedure. Chest X-radiograph (CXR) showed bilateral tension pneumothorax (Figure 1). Two chest tubes were immediately inserted (one on each side of chest) and she was transferred to the paediatric intensive care unit (PICU) for further care.

In the PICU, she was sedated and paralysed with midazolam and atracurium infusions, and supported by mechanical ventilation. Chest examination revealed satisfactory air entry with prolonged expiratory phase, diffuse crepitation and rhonchi. The liver edge was 2 cm below the right costal margin.

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The CXR revealed re-expansion of both lungs with diffuse haziness in the right middle zone (Figure 2). The first blood gas showed significant metabolic acidosis: pH 7.17, PaO_2 67.7 mmHg, $PaCO_2$ 28.8 mmHg, bicarbonate 10.5 mmol/l and base excess -16.9. The complete blood picture was normal: white blood cell count 7.5 x 10^9/l (neutrophil/lymphocyte 3.7/3.1 x 10^9/l), haemoglobin 11.7 g/dl, platelet count 404 x 10^9/l. Nasopharyngeal aspirate (NPA) was positive for RSV, and negative for adenovirus, influenza A & B, parainfluenza and Chlamydia trachomatis. Per-nasal swab for Bordetella pertussis was negative. Endotracheal tube aspirate and blood for bacterial culture were also negative. The liver and renal function tests were normal. She was treated with intravenous cefotaxime.

In view of the problem of air-trapping in severe acute bronchiolitis, the ventilation strategy of permissive hypercapnia was adopted in order to minimise further barotraumas to the lungs. She was being ventilated with pressure control mode using Infant Star ventilator. On day 1, the inspiratory/expiratory ratio was 1 to 4 and respiratory rate 25/min; the highest positive inspiratory pressure (PIP) and positive end-expiratory pressure (PEEP) were 27 cmH_2O and 5 cmH_2O respectively. Nebulised salbutamol was given through the ventilator circuit to relieve the small airway obstruction. She showed satisfactory response and her progress in the PICU was good. The highest $PaCO_2$ was 70.1 mmHg (9.2 kPa) at 10 hours and the blood gas finally normalised at 36 hours of PICU care. She was extubated on day 3. The left side chest tube was removed on day 5 and the right side chest tube on day 6. There was no recurrence of pneumothorax. She left the PICU on day 7 and was discharged from the hospital on day 11. She was last seen at the age of 1½ years old and was found to have normal development and the examination of the respiratory system was normal.

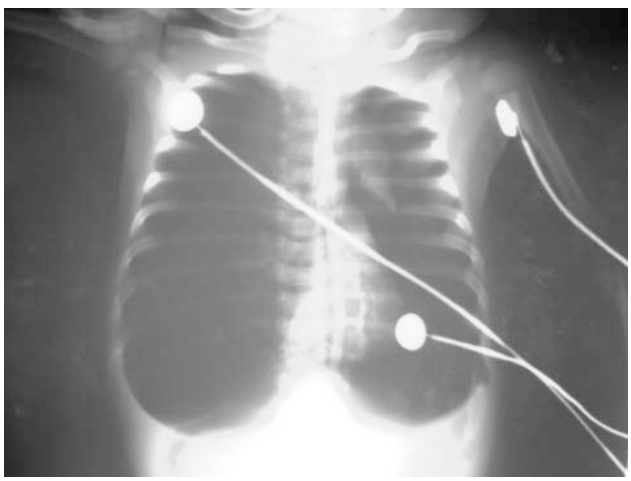

Figure 1 Chest radiograph showing bilateral pneumothorax.

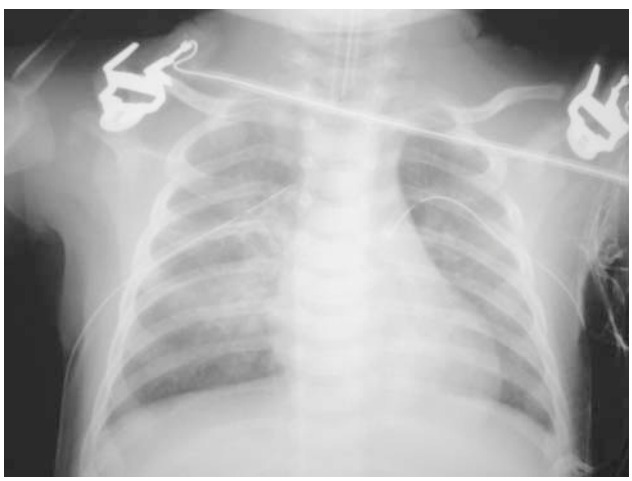

Figure 2 Chest radiograph showing re-expansion of bilateral lung fields with 2 chest tubes inserted.

Discussion

Acute bronchiolitis is a common cause for childhood hospitalisation. In US, Shay et al found that the annual bronchiolitis hospitalisation rate was 31 per 1000 infants per year in 1996, and RSV was the most important cause of bronchiolitis.[1] Most of the patients with acute bronchiolitis recover uneventfully. Spontaneous pneumothorax caused by RSV bronchiolitis is rare. A case of spontaneous bilateral pneumothorax was reported in 1987 by Pollack et al. Because of the small-sized pneumothoraces, the patient was successfully treated with simple aspiration.[2]

Pneumothoraces are divided into post-traumatic, iatrogenic and spontaneous which is further classified as primary spontaneous pneumothorax and secondary spontaneous pneumothorax.[3] For post-traumatic pneumothorax, it can be penetrating or non-penetrating thoracic injury. Thoracocentesis, lung biopsy and artificial ventilation are examples causing iatrogenic pneumothorax. Primary spontaneous pneumothorax occurs in patients with no pre-existing lung disease whereas secondary spontaneous pneumothorax occurs in patients with predisposing lung disease or pulmonary anatomical abnormality such as hyaline membrane disease and congenital pulmonary hypoplasia in newborns, cystic fibrosis, bronchiolitis and asthma. In paediatric group of patients, primary spontaneous pneumothorax is the

commonest and mainly occurs in teenagers with tall and slim stature.[4-5] The other group of patients vulnerable to pneumothorax are those receiving ventilator therapy for their primary severe respiratory diseases including acute respiratory distress syndrome, pneumonia, asthma, bronchiolitis, pulmonary congenital diseases and foreign body aspiration.[6]

We report a case of life threatening bilateral tension pneumothorax complicating artificial ventilation in a patient suffering from RSV bronchiolitis. The patient was hypoxic and lapsed into respiratory failure which warranted emergent intubation and artificial ventilation. She showed good response in the beginning. During resuscitation, hand ventilation is usually performed too energetically i.e. using too high a pressure and rate. This is very risky in patient with air trapping conditions like asthma or bronchiolitis. The uncontrolled manual ventilation can result in more severe air trapping, and ultimately, the alveoli ruptured resulting in bilateral tension pneumothorax.

Mechanical ventilation for patients with bronchiolitis is not an easy issue. The small airway obstruction and inflamed oedematous alveoli makes the lungs very prone to exaggerated air trapping and barotraumas which will further cause air leaks in the lung such as pneumothorax and pneumomediastinum. Briassoulis et al found that there was strong positive correlation between the incidence of air leaks and high ventilatory pressure or large tidal volume which induced barotraumas to the lungs.[6]

In order to minimise excessive intrapulmonary pressure and further lung injury, we adopted the ventilation strategy of permissive hypercapnia.[7,8] A slow respiratory rate and prolonged expiratory time was used to allow adequate time for expiration, so as to avoid further air trapping. PEEP was kept at a minimum level because high auto-PEEP is a characteristic of bronchiolitis. PIP and FiO_2 were kept at optimal levels to prevent hypoxia. This strategy of permissive hypercapnia without hypoxia appears to have little serious adverse effect. The safe limits for pH and $PaCO_2$ are not known, but it has been suggested to keep the pH above 7.15 and $PaCO_2$ below 80 mmHg.[9,10]

Similar ventilation strategy should apply to hand ventilation on this patient in the AED. One should bag gently and slowly to allow adequate time for expiration so as to minimise barotraumas. One can ensure complete expiration by listening to the expiratory breath sounds with auscultation. In case of sudden deterioration in an intubated patient, one should try to identify the causes with the use of the DOPE mnemonic suggested in paediatric advanced life support (PALS) provider course,[11] which means displacement of the tracheal tube out of the airway or into a main bronchus, obstruction of the tracheal tube, pneumothorax or equipment failure. Among these causes, tension pneumothorax is high in the list in patients with small airway obstruction; hence one has to look for clinical features of tension pneumothorax, which include hyper-inflated chest, hyper-resonant percussion note, pushing down liver edge and poor lung compliance with limited air entry. Needle thoracostomy is a rapid and reliable bedside test as well as an emergency treatment for tension pneumothorax. CXR is the definite method of diagnosing pneumothorax, but it should not delay the resuscitation procedure in the critical condition.

In summary, bronchiolitis is commonly an uneventful illness, but life-threatening complications like respiratory failure will occur. For those patients requiring artificial ventilation, precaution has to pay to minimise the risk of barotraumas and the subsequent tension pneumothorax. We advocate the strategy of permissive hypercapnia for both hand and mechanical ventilation in patients with respiratory failure complicating bronchiolitis. Tension pneumothorax is an uncommon but fatal complication of artificial ventilation on patients with air trapping lung disease such as bronchiolitis and asthma, so rapid diagnosis and prompt treatment is of upmost importance.

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