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Pneumatoceles and pneumothoraces complicating staphylococcal pneumonia: treatment by synchronous independent lung ventilation

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Abstract

A 54 year old man with a staphylococcal sepsis developed staphylococcal pneumonia complicated by multiple pneumatoceles and bilateral tension pneumothoraces caused by bronchopleural fistulae. Excessive enlargement of the right sided pneumatoceles and a tension pneumothorax not improved by drainage led to mediastinal shift and compression of the right lung. Reversal of the mediastinal shift and closure of the bronchopleural fistulae was achieved by assisted independent lung ventilation.

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Staphyloccocal pneumonia in the course of a staphylococcal septicaemia is uncommon and has a poor prognosis.[1-3] Pneumatoceles have been described as a complication of staphylococcal pneumonia in children[4 5] but are rare in adults.[6 7]

We describe the case of a man who developed multiple pneumatoceles due to bacteraemic staphylococcal pneumonia. Subsequent pneumothoraces with bronchopulmonary fistulae and mediastinal shift required treatment with independent lung ventilation.

Case report

A 54 year old man with gout developed an ingrowing toenail with painful, erythematous swelling of the toe and forefoot three days before admission. Ampicillin was prescribed but the cellulitis progressed. One day before admission the patient developed a fever and dyspnoea.

On admission the patient was tachypnoeic (30 beats/min) and mildly breathless at rest. The chest radiograph showed diffuse patchy infiltrates in both lungs. Blood gas analysis on air showed an arterial oxygen tension (PaO_2) of 68 mm Hg, an arterial carbon dioxide tension ($PaCO_2$) of 37 mm Hg, an oxygen saturation of 90%, and a negative base excess of 5 mmol/l. Antibiotic treatment was started with amoxycillin, clavulinic acid, and gentamicin, but changed after 48 hours to imipenem, flucloxacillin, and gentamicin. Supplemental nasal oxygen was delivered at 2 l/min and increased to 4 l/min after eight hours.

The next day the patient became increasingly septicaemic. He required intubation and artificial ventilation, with initially a positive end expiratory pressure (PEEP) of 5 mm Hg and a maximum positive airway pressure of 30 mm Hg with an inspiratory oxygen concentration (FiO_2) of 0·45. Progression of the patchy infiltrates paralleled deterioration in respiratory function necessitating an FiO_2 of 0·6, a PEEP of 10 mm Hg, and an inspiratory to expiratory ratio of 1:1. Blood cultures and culture of tracheal aspirates grew *Staphylococcus aureus* sensitive to the antibiotics given. The inflamed left foot was incised and in the deeper layers necrotic tissue and pus were removed. Culture of this material also grew *Staph aureus*.

On the fifth day a left tension pneumothorax developed and an intercostal drain was inserted. Twelve hours later a right sided tension pneumothorax developed necessitating bilateral intercostal suction drainage. Maximum inspiratory pressure and PEEP were reduced as far as possible, but the pneumothoraces persisted. Larger drains were inserted but this led to greater air leaks up to 40% of the inspired volume. Chest radiography showed the development of pneumatoceles (fig 1).

The pneumatoceles and the left pneumothorax increased causing marked mediastinal shift to the right and synchronous independent lung ventilation was attempted to rest the left lung. On the 16th hospital day a tracheostomy was performed and a left double lumen endotracheal tube (Broncho-Cath, Mallinckrodt, Hennef, Germany) was introduced. The patient was ventilated with two synchronised C900-Servo ventilators (Siemens, Munich, Germany) providing synchronous spontaneous pressure support ven-

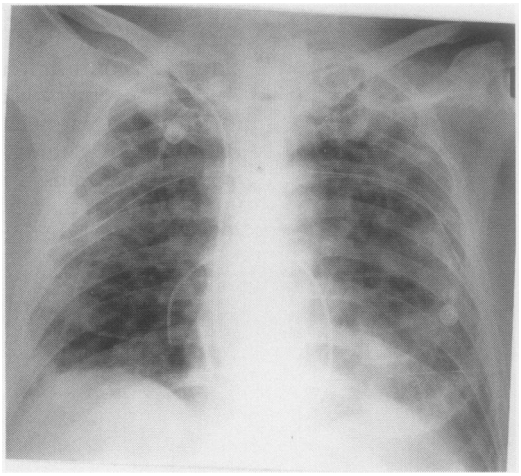

Figure 1 Chest radiograph on day 9 showing bilateral pneumatoceles, a pneumothorax on the left, and bilateral thoracic drains.

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tilation to both lungs with independent pressures and tidal volumes. A positive pressure support of 15 mm Hg for the right lung and initially no pressure support for the left lung was used. The tidal volume in the right lung increased from 260 ml to 400 ml within five hours and decreased in the left lung from 150 ml to 50 ml at a respiratory rate of 30/min. Leakage through the bronchopleural fistula on the left ceased within three hours and the mediastinum became central again. The arterial blood gases remained stable despite the partial collapse of the left lung.

The pressure support for the left lung was then slowly raised to 8 mm Hg allowing an increase in tidal volume to 150 ml and gradual re-expansion of the left lung. After 48 hours of independent lung ventilation the double lumen endotracheal tube was exchanged for a standard tracheostomy tube and the patient weaned by intermittent spontaneous breathing and assisted spontaneous breathing with a pressure support of 10 mm Hg. The smaller right sided bronchopulmonary fistula closed, the left lung continued to re-expand, and the patient was weaned completely within one week. The pneumatoceles were confirmed during recovery by computed tomography (fig 2).

Discussion

Positive pressure ventilation can encourage progressive enlargement of pneumatoceles with consequent rupture leading to bronchopleural fistulae and tension pneumothoraces. In this situation alternative ventilatory techniques include high frequency jet ventilation or independent lung ventilation.

A decrease in mean airway pressure and a diminution in the wide fluctuations of airway pressure of normal positive pressure ventilation are considered the prime advantages of high frequency ventilation.[8] Low ventilatory airway pressure may reduce lung injury[8] and is superior to conventional positive pressure ventilation in the management of bronchopleural fistula.[9] The efficacy of high frequency ventilation is, however, limited by potential drawbacks. In particular, the continuous application of positive pressure may allow air leakage through the bronchopleural fistulae to persist and sustain, or even enlarge, existing pneumatoceles. In addition, high frequency jet ventilation is not available in most intensive care units.

Independent lung ventilation is used mostly in thoracic and trauma surgery and is usually confined to the operative and immediate postoperative period. Its use in bronchopleural fistulae and severe unilateral pneumonia has been described,[10–12] but experience with independent lung ventilation in bronchopleural fistulae is limited.[12] It is the only technique that would allow adequate ventilation without positive pressure to one lung, and is useful if there is a large bronchopleural fistula and air leak.

Technically, independent lung ventilation is complex. The double lumen endotracheal tube needs precise positioning and this is best confirmed bronchoscopically. Dislocation can occur especially during normal nursing procedures. The small diameter of the two lumens can cause difficulties with suction and may limit ventilatory flow, and the double lumen catheters are fitted with low volume, high pressure cuffs that may induce airway injury. Left sided double lumen endotracheal tubes should be used preferentially as the lower cuff of the right sided tube tends to obstruct the upper lobe bronchus. Particular care needs to be taken to keep the cuff pressures on both sides above the overall maximum inspiratory pressure otherwise the higher pressure from one side will also be applied to the other side (recognisable by altered peak pressures and discrepancies between inspiratory and expiratory tidal volumes).

As the requirements for independent lung ventilation (two synchronisable ventilators, double lumen endotracheal tubes, and paediatric bronchoscope) will be available in most major hospitals, this technique should be considered in the management of large bronchopleural fistulae.

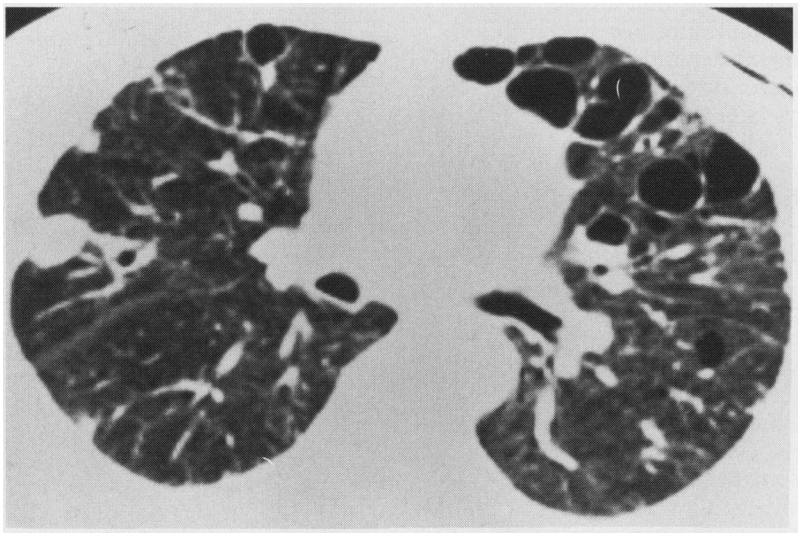

Figure 2 Computed tomography of the chest four weeks after independent lung ventilation showing the remaining pneumatoceles.

We are grateful to the nursing staff for their skilled care of this patient.

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Pulmonary and cutaneous vasculitis following hepatitis B vaccination

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Abstract

The case history is presented of a previously healthy non-atopic woman who developed cutaneous vasculitis, confirmed by biopsy, and pulmonary problems after inoculation with recombinant hepatitis B vaccine.

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Vaccination with hepatitis B recombinant vaccine is highly effective in producing immunity in immunocompetent patients. It has few side effects, usually consisting of early local reactions to the thimerosal or aluminium components of the vaccine.[1–3] We report a case of cutaneous vasculitis, confirmed by biopsy, who also had pulmonary problems after the first inoculation with recombinant hepatitis B vaccine.

Case report

A previously healthy 45 year old non-atopic woman taking no regular medication received her first dose of recombinant hepatitis B vaccine (20 μg in 1 ml, Engerix B; Smith, Kline and Beecham). Two days later she developed a pruritic rash on both feet which spread to her trunk and face. Over the next few days she developed breathlessness on minimal exertion, severe malaise, Raynaud's phenomenon, and a symmetrical polyarthralgia affecting her hands, wrists, elbows, and feet. In view of her multiple problems, admission to hospital was arranged.

On examination she was ill with a maculopapular rash over most of her body. Mobility of her hands was reduced because of arthralgia but no arthritis was evident. Nail bed infarcts were present along with necrosis of the distal finger pulps, in keeping with a digital vasculitis. Auscultation of her chest revealed fine inspiratory crackles at both bases. No abnormality was found in her eyes.

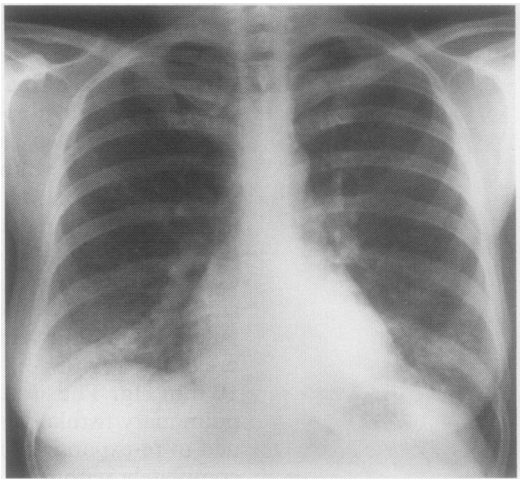

Figure 1 Chest radiograph on admission.

Investigations showed no microscopic haematuria; urea concentration, liver function test results, plasma viscosity, and full blood count were normal, with no eosinophilia present. The chest radiograph showed bilateral basal mottling (fig 1), and results of pulmonary function tests revealed a restrictive pattern (FEV_1/FVC ratio 80%) with small lung volumes and a gas transfer corrected for lung volume (KCO) of 69% predicted.

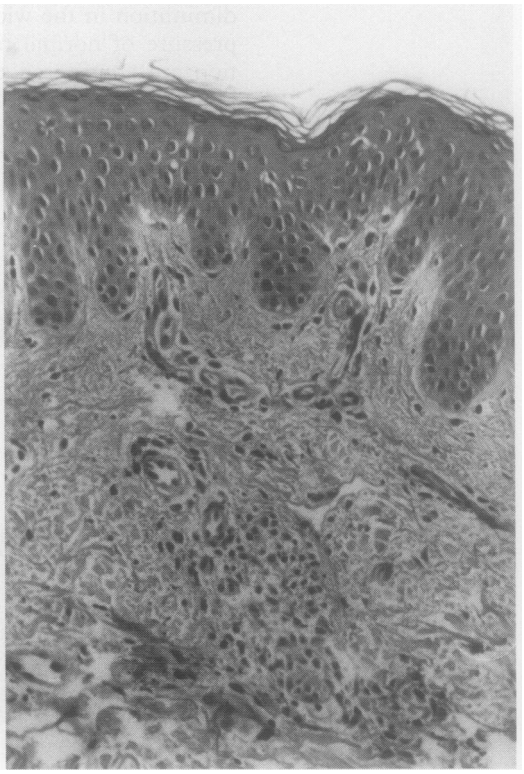

Figure 2 Photomicrograph of skin biopsy specimen showing perivascular infiltrate in keeping with vasculitis.

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