diagnosed hypercalciuria on the results of testing a single urine collection. We believe it is important to record persistent hypercalciuria by testing repeated urine collections, as a single collection may be misleading.

The fact that two of our five hypercalciuric patients (both of whom had had episodes of gross haematuria) went on to develop calculi suggests that such patients should be treated. As idiopathic hypercalciuria is a lifelong, usually asymptomatic condition such treatment should probably be limited to recommending a diet low in calcium and ensuring that even patients who have never shown any evidence of stones in the renal tract should drink enough fluid.

References

- 1 Roy S III, Stapleton FB, Noe HN, Jerkins G. Hematuria preceding renal calculus formation in children with hypercalciuria. *J Pediatr* 1981;**99**:712-5.
- 2 Kalia A, Travis LB, Brouhard BH. The association of idiopathic hypercalciuria and asymptomatic gross hematuria in children. *J Pediatr* 1981;**99**:716-9.
- 3 Moore ES. Hypercalciuria in children. In: Berlyne GM, ed. *Contributions to nephrology*. New York: Karger, 1981:20-32.
- 4 Hymes LC, Warshaw BC. Idiopathic hypercalciuria. Renal and absorptive subtypes in children. *Am J Dis Child* 1984;**138**:176-80.
- 5 Stapleton FB, Roy S III, Noe HN, Jerkins G. Hypercalciuria in children with hematuria. *N Engl J Med* 1984;**310**:1345-8.

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Pulmonary interstitial emphysema: selective bronchial occlusion with a Swan-Ganz catheter

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SUMMARY A 26 week preterm infant ventilated for hyaline membrane disease developed severe pulmonary interstitial emphysema with extensive right sided bullous formation, mediastinal shift, and subsequent left sided atelectasis. A paediatric Swan-Ganz catheter was used for selective bronchial occlusion with dramatic improvement in the infant's clinical condition and radiographic findings.

Case report

A girl weighing 760 g was born at 26 weeks' gestation by a vaginal breech delivery with an Apgar score of 5 and 6 at one and five minutes, respectively. The baby required mechanical ventilation almost immediately for moderately severe hyaline membrane disease (inspiratory pressures 14/3 cm H₂O; fractional inspiratory oxygen (FiO₂) 1.0). The initial chest radiograph taken five hours after birth showed early signs of bilateral PIE. At 12 hours of age a right pneumothorax occurred and was drained. Further deterioration in oxygenation necessitated increased ventilation (pressures 22/2 cm H₂O; FiO₂ 1.0). Ventilator support remained unchanged until day 16, when radiographs indicated a worsening PIE that was associated with further hypoxaemia. Stabilisation proved difficult with recurrence of a right pneumothorax after increasing ventilatory pressures to 37/2 cm H₂O; FiO₂ 0.8. Despite dependent positioning of the right emphysematous lung and carefully monitored ventilation, the infant continued to deteriorate.

On day 18 selective intubation of the left mainstem bronchus under fluoroscopy was unsuccessful. The radiographic findings (fig 1) showed large cystic lucencies with hyperaeration and a persistent herniation of the right lung across the midline with mediastinal displacement to the left. At this time the

Pulmonary interstitial emphysema (PIE) occurs as a complication of mechanical ventilation in infants with underlying hyaline membrane disease. The use of high peak ventilatory pressures with resultant barotrauma leads to extrapulmonary effusions of air along peribronchovascular, pleural, and interlobular passages from ruptured alveoli.¹ The morbidity from the presence of such interstitial gaseous blebs stems largely from hypoxia secondary to a ventilation/perfusion imbalance in an already compromised infant. Accumulation of unilateral interstitial air may also result in bullous air pockets with eventual mediastinal shift and compression of the contralateral lung.

We report our experience with selective bronchial occlusion of the right mainstem bronchus with a Swan-Ganz catheter in a preterm infant with life threatening complications of PIE.

Fig 1 Large cystic lucencies of the right lung with hyperaeration and mediastinal shift to the left side. Two pneumothorax chest drains are shown on the right.

infant developed acute renal failure with intermittent hypotension concurrent with worsening arterial oxygen desaturation (pH 7.17, PCO_2 10.4 kPa, PO_2 5.7 kPa, bicarbonate 28 mmol/l). A decision was made to reattempt collapse of the right lung. This was easily achieved with a Swan-Ganz model 93-117-5 French double-lumen paediatric-flow directed monitoring catheter which was inserted into the right mainstem bronchus with balloon inflation to 0.8 mm diameter. The infant was then intubated with a No 2.5 endotracheal tube that was appropriately positioned above the level of the carina. The procedure was well tolerated and resulted in rapid reduction in inspiratory pressures and improvements in blood pressure, peripheral circulation, and oxygenation (pH 7.39, PCO_2 7.1 kPa, PO_2 7.6 kPa, bicarbonate 32 mmol/l). A chest film three hours later showed atelectasis of the middle and lower lobes of the right lung (fig 2) with a shift of the mediastinum to the midline and re-expansion of the left lung. The Swan-Ganz catheter was deflated intermittently for five minutes

Fig 2 Partial atelectasis of the right lung with Swan-Ganz catheter in place.

every hour, to help minimise bronchial wall pressure necrosis. Forty eight hours later the left lung developed progressive radiological changes of PIE. The Swan-Ganz catheter was deflated for 12 hours and left in situ and then partially reinflated for a further 12 hours before being removed. Gradual re-aeration of the right lung occurred with subsequent bilateral reabsorption of all the PIE. The infant was extubated at 9 weeks of age and has evidence of minimal bronchopulmonary dysplasia.

Discussion

Selective bronchial occlusion has been reported as a successful alternative in the treatment of localised PIE.²⁻⁴ The devices previously used to treat the diseased lung were not without procedural hazard. Mathew and Thach accomplished occlusion of the right mainstem bronchus with an umbilical catheter adapted with a handmade oesophageal pressure balloon,² while DeWitte *et al* used a modified endotracheal tube with an occluded distal end.³ Auerbach *et al* used operative intervention for the insertion of a Fogarty balloon catheter at bronchoscopy in the management of localised cystic PIE.⁴ We chose a Swan-Ganz catheter because it is a safe and reproducible piece of equipment that can be easily inserted without large scale instrumentation that may further compromise the premature infant with PIE. The advantages of our procedure are that:

(1) It is accomplished easily and quickly without fluoroscopy. (2) It comprises simple laryngoscopy with subsequent reintubation of the infant with a 0.5 mm smaller endotracheal tube to permit adjacent placement with the Swan-Ganz catheter. (3) A successful response is seen within half an hour of the procedure with ongoing improvement in the radiological findings. (4) The catheter is radiolucent and clearly marked in 5 cm increments with a sliding gate valve that prevents inadvertent deflation of the balloon. (5) Using a syringe, precise quantitation of the degree of balloon inflation is possible, and although location of the balloon is known (0.9 cm from the catheter tip) its exact position can be determined by insufflating the balloon with dilute contrast fluid. Pulmonary interstitial emphysema should be managed aggressively in the first instance by non-invasive methods. Selective bronchial occlusion utilising a Swan-Ganz catheter provides a

successful alternative measure in severe disease unresponsive to standard treatment.

References

- ¹ Plenat F, Vert P, Didier F, Andre M. Pulmonary interstitial emphysema. *Clinics in Perinatology* 1978;5:351-7.
- ² Mathew OP, Thach BT. Selective bronchial obstruction for treatment of bullous interstitial emphysema. *J Pediatr* 1980;96:475-7.
- ³ DeWitte DB, Batton DG, Prudent L, Maisels J. Endotracheal tube modification for therapy of right-sided pulmonary interstitial emphysema. *Clin Pediatr (Phila)* 1986;25:626-8.
- ⁴ Auerbach DA, Blackmon LR, Filston HC, Merten DF, Kirks DR. Localized pulmonary interstitial emphysema: treatment by bronchial occlusion. *American Journal of Perinatology* 1983;1:52-7.

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Effect of tilting on oxygenation in newborn infants

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SUMMARY Transcutaneous (tc) PO₂ in newborn infants increased on head up tilting (median increase 0.5 kPa at term, 1.0 kPa preterm). Head down tilting was associated with an equivalent fall in tcPO₂. There was no change in tcPCO₂. Tilting of infants mechanically ventilated for respiratory distress syndrome or surgery produced no consistent change in PO₂.

Newborn infants are often nursed on a head up tilt. This study investigated whether a head up or head down tilt produced a change in PO₂ and PCO₂ in healthy prone newborns and in those with respiratory problems.

Patients and methods

Seventeen healthy term infants and seventeen healthy preterm infants (mean birth weight 1300 g) were studied at the Department of Neonatology, Ullevaal Hospital, Oslo. Each term infant lay prone and at least five tilts were performed. Each position: horizontal, 30 degrees head up, and 30 degrees head down, was held for five minutes before the next tilt. The term infants were studied on day one and day

five in active and in quiet sleep. The preterm infants were studied on one day only and tilted 20 degrees head up in their incubators. Transcutaneous PO₂ and PCO₂ were measured in the interscapular region. Values were recorded every 30 seconds. Tilts associated with any body movement or change in sleep state were not included.

To investigate the possibility that tcPO₂ might be influenced by changes in skin circulation from hydrostatic pressure or reflex vasoconstriction due to a baroreceptor response we measured tcPO₂ from two electrodes, one in the intrascapular region and one on the buttock in five infants. TcPO₂ values from both sites followed each other exactly (fig 1) thus ruling out a gravitational effect on local skin perfusion.

Further studies of PO₂ and head up tilting were carried out in 10 infants receiving intensive care at Hammersmith Hospital, London. Seven of these infants had an umbilical artery catheter with an oxygen electrode at the tip in the descending aorta. The remaining three infants were studied using a transcutaneous PO₂ system.

Results

Fig 1 shows a typical response with PO₂ rising and