

Imaging techniques in respiratory medicine

## Two imaging techniques to find too flexible an airway: looking for malacia

S Cunningham

A perspective on the article by Mok *et al* (see page 290)

Infants who fail to wean from mechanical ventilation, or who do so only with considerably increased work of breathing and oxygen requirement, pose a major clinical challenge. Such infants are often preterm, but may also have cardiovascular, respiratory, or surgical comorbidities (tracheo-oesophageal fistula, diaphragmatic hernia, etc). They are prone to periodic, grumbling respiratory exacerbations and sometimes recurrent, frighteningly acute, severe respiratory compromise. Apportioning the relative contribution of chronic lung disease (or other comorbidity) to possible tracheobronchomalacia in the pathophysiology of these events is difficult, but this consideration is important in helping to inform effective management strategies.

In this issue, Mok *et al* discuss the relative merits of two methods for assessing malacia of the airway in ventilator dependent infants. Most of the infants in their report were preterm, although others have reported large cohorts of children with other comorbidities who also have associated tracheobronchomalacia.<sup>1</sup>

The paper provides three messages, and raises three questions.

- (1) Tracheobronchomalacia was universal in their population of ventilator dependent preterm infants.
  - How common is tracheobronchomalacia in the general preterm population and who should be investigated?
- (2) Safety remains an important consideration when investigating young infants.
  - What is the best and safest way to obtain information on the dynamic function of the airways?
- (3) Continuous positive airway pressure (CPAP) therapy for tracheobronchomalacia can be titrated using imaging techniques.
  - What therapeutic options are available for the medical management

of patients with tracheobronchomalacia?

The paper studied 16 infants who were ventilator dependent in a selected population at a tertiary centre. When bronchography was used as the yardstick, tracheobronchomalacia was present in 100%. If the prevalence in this study was so high, how common is tracheobronchomalacia in preterm infants? Clinically, tracheobronchomalacia can produce persistent cough (difficulty clearing secretions), recurrent respiratory exacerbations, persistent chest radiographic changes, increased work of breathing, and chronic oxygen requirement, all problems commonly encountered in the preterm infant with chronic lung disease. Preterm susceptibility to tracheobronchomalacia probably relates to mid-gestational disruption of cartilage development.<sup>2</sup> The incidence of tracheobronchomalacia in the preterm population is poorly documented, probably because of difficulties with diagnosis. In preterm infants with an oxygen requirement at 36 weeks postconceptional age, 15–25% have moderate to severe tracheomalacia identified by flexible bronchoscopy.<sup>3,4</sup> Flexible bronchoscopes are sometimes considered to temporarily stent the airway during the examination, and so it is possible this figure is higher.

The symptoms associated with tracheobronchomalacia are present in many children who require home oxygen for bronchopulmonary dysplasia; such symptoms may also arise from the peripheral pulmonary injury associated with preterm birth. If oxygen weaning is rapid and symptoms few, then investigation may not be warranted; infants with a more protracted and variable course, however, could benefit from investigation for associated tracheobronchomalacia.

Investigation of tracheobronchomalacia requires good planning to minimise the risk of airway assessment in infants with significant respiratory instability. Skilled radiology colleagues are invaluable.

In severe cases, fluoroscopic screening of the airways may be sufficient to identify tracheomalacia. This technique does not require an anaesthetic. The information obtained, however, is limited; it is difficult to quantify the degrees of malacia, the bronchi are difficult to assess properly, and titration of CPAP is not practical.

Flexible bronchoscopy is often used to assess tracheobronchomalacia. In skilled hands, malacia is commonly identified in older children with respiratory symptoms.<sup>5</sup> In preterm infants, the relative size of the bronchoscope to the airway and the difficulties of maintaining respiratory stability during the procedure may limit the quality of information obtained. Rapid skilled assessment using ultrathin flexible bronchoscopes can be useful, and, if necessary, bronchograms can be performed with contrast directed through the channel of the bronchoscope. An anaesthetic will be required, but the procedure, if rapid, carries little additional risk.

The paper by Mok *et al* compared two other modes of investigation: bronchography and dynamic computed tomography (CT).

Bronchography has played a pivotal role in the evolution of radiological imaging of the airways.<sup>6</sup> Principal in the diagnosis of bronchiectasis, its role appeared redundant with the development of CT. Changes in modern health care have provided a continued role for this investigation. The ability of bronchography to provide dynamic images of the airways is not new, but it is novel to many of the conditions that we now investigate.

The availability of new radio-opaque contrast materials has been important for the resurgence of bronchography in children. Traditional oil based, dense, inert contrasts ceased production when CT scanning became predominant. Such contrasts provided excellent images, but were not absorbed and needed to be completely removed from the lung after the procedure. Although fully absorbable water based contrasts remained available, they were hypertonic and consequently caused bronchospasm. Fortunately, new water based isotonic contrast materials have now become available which are non-ionic with a lower iodine concentration (hence adequate density) and can be used in small volumes. The paper of Mok *et al*, and others,<sup>1</sup> demonstrate that bronchography can be a safe, dynamic, and informative technique when performed by a skilled team.

Dynamic imaging of the airways by CT scanning has been proposed as the definitive method for assessing airway

instability. Unfortunately, many CT scanners are still not dynamic enough for the assessment of unstable preterm infants with high respiratory rates. Multiheaded scanners may improve on this, but radiation exposure will remain an important check on the use of these techniques in the very young. Although radiation exposure was reduced to a minimum in the study of Mok *et al*, the CT effective radiation dose remained almost four times that of exposure during a bronchogram (and up to 500 times a single dose for a chest radiograph). It is unlikely that radiation exposure will reduce significantly with newer multiheaded dynamic scanners, particularly when the advantage of such scanners will be increased acquisition of dynamic data (making it more comparable to bronchography), with an associated increase in radiation exposure.

Medical treatment options for tracheobronchomalacia are limited. In the most severe cases, those who cannot be weaned from ventilation, tracheostomy (sometimes with custom length tube)

together with CPAP/bilevel pressure support is required. The ability to titrate pressure support during investigation (by bronchography, CT, or bronchoscopy) is valuable in terms of assessing the degree of compromise. In less severe cases, providing CPAP via a nasal mask for portions of the day can (in our experience) help reduce the work of breathing, improve growth, reduce or eliminate oxygen requirements (even at times not on CPAP), and reduce respiratory exacerbations. There are no trials of such intervention; they would be useful. In moderate cases, simple support includes physiotherapy to help clear secretions, a lower threshold for antibiotics, and additional calorie support to aid growth. Inhaled corticosteroids and bronchodilators would not have a place in the treatment of such infants.

Mok *et al* conclude that bronchography is the investigation of choice in ventilator dependent preterm infants. It may be useful to consider the technique in a broader group of infants with respiratory instability, particularly those who are preterm.

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