Diagnosis and management of subglottic stenosis after neonatal ventilation

Acquired subglottic stenosis may occur after any intubation but is commonest after intubation in premature neonates in whom the incidence is between 1% and 8%. Recent recognition of the problem has led to more careful management of endotracheal tubes. It is now known that multiple intubations, tight fitting tubes with no air leak, excessive tube movement, and prolonged intubation all predispose to the development of stenosis. The use of a nasotracheal tube fixed to the forehead with a Tunstall connector minimises movement. The Cole pattern tube has a shoulder which tends to wedge in the subglottis and cause stenosis, and should be used for resuscitation only: a parallel sided tube should be used if intubation is to be continued.

Diagnosis

HISTORY
A child with subglottic stenosis after intubation may present with failure of extubation, stridor, recurrent 'croup', or reduced exercise tolerance. A hoarse voice or cry may be noted if scarring has involved the vocal cords. A history of previous intubations with special reference to the problems mentioned above must of course be sought.

PHYSICAL EXAMINATION
In stridulous patients assessment of the adequacy of the airway is paramount. Increased inspiratory effort with use of accessory muscles increases negative intrathoracic pressure leading to tracheal tug, intercostal, subcostal, and sternal recession. Some information can be gained from the demeanour of the child: lack of spare energy for playing or talking is significant.

Increased respiratory and pulse rates are common in these situations but cyanosis and bradycardia are ominous signs of decompensation.

Stridor in subglottic stenosis is inspiratory but may become biphasic as obstruction worsens.

SPECIAL INVESTIGATIONS
Radiographs should include a lateral soft tissue view of the neck, a posterior-anterior view of the chest, a high kilovolt coned tracheal ('Cincinnati') view, and a barium swallow.

All patients with appreciable stridor require microlaryngoscopy and bronchoscopy to assess the state of the larynx and the severity of the stenosis.

The size of the subglottis is measured using the bronchoscope (a normal neonatal subglottis should have a diameter of 5-0 mm and admit a size 3-0 Storz ventilating bronchoscope).

An accurate assessment demands optimum anaesthetic conditions. Secretions are reduced by atropine premedication and the larynx is sprayed with a metered dose of lignocaine to prevent laryngospasm during instrumentation. Spontaneous respiration is maintained throughout the examination, using an anaesthetic mixture of halothane and oxygen, with careful monitoring to avoid hypoxia.

Treatment
If an infant has an airway that is inadequate there are two ways of approaching the problem. The traditional approach is to perform a tracheostomy and assess the child's airway every three months to decide whether reconstructive surgery is needed as the child grows. This has the advantage of getting the child back to a normal life as quickly as possible but carries an associated mortality of up to 10%. The day to day management of a tracheostomy can be difficult for parents, and for some children speech development is delayed.

The second option is to perform a cricoid split. There are several modifications of this procedure but the basic principles are the same. Under general anaesthesia the anterior lamina of the cricoid is divided and the edges distracted to enlarge the subglottic lumen. Some surgeons also split the posterior lamina and may even make lateral cuts in the cricoid. The endotracheal tube is then changed, on the operating table, for the largest size possible (usually a size 3-5 Portex). This tube stays in for 10 days while the child is paralysed and ventilated. Intravenous steroids are given for the final 24 hours and extubation is attempted. The operation can be repeated if necessary. The advantage is avoidance of a tracheostomy in approximately 75% of cases, but it does require use of intensive care facilities for a prolonged period of ventilation.

If a tracheostomy has been performed then sizing of the subglottis at intervals will decide whether reconstructive surgery is required. As a 'rule of thumb' a subglottic diameter more than one bronchoscope size too small for the age of the child will require surgical widening. In the absence of a tracheostomy then a decision about surgery will be based more on severity of symptoms.

The operation of choice for acquired subglottic stenosis is the laryngotracheal reconstruction using an autologous costal cartilage graft. Ideally this is performed at about the age of 2 years or when the child reaches 10 kg in weight.

Laryngotracheal reconstruction is performed through a separate incision above the tracheostomy at the level of the cricoid: the larynx is exposed from hyoid above to tracheostome below. The lumen is entered above the superior thyroid notch and the larynx is incised strictly in the midline to below the cricoid cartilage, through the stenotic segment. According to the severity and the distribution of the stenosis, an anterior and/or posterior graft is inserted to widen the cricoid ring. The graft is taken from a section of the eighth costal cartilage and sutured into place. A Silastic stent is used to prevent the graft prolapsing and this is removed endoscopically after approximately eight to 12 weeks. During closure of the laryngofissure incision it is vital to appose the anterior commissure accurately or serious voice disturbance will result.
Once the subglottis is seen to be healed with a good airway, decannulation under hospital supervision can be attempted.\textsuperscript{1,2} This usually occurs three to six months after surgery, and is successful in over 80% of cases.\textsuperscript{2}

Complications of the operation include pneumothorax from the graft harvesting, and difficulty in swallowing which is usually temporary. Aspiration of food may occur if the Silastic roll is too high in the larynx in which case the stent is trimmed endoscopically. Late complications such as poor voice quality can occur,\textsuperscript{11,20} especially if the graft is too high causing blunting of the anterior commissure or if the larynx is not closed correctly. Failure of the operation due to fibrosis or graft prolapse may require revision surgery.

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