Anaesthesia for laryngeal/Tracheal surgery in children  
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Lesions and surgical procedures on the larynx are diverse, this abstract overviews their management.

**Closed operations on the larynx**

Short therapeutic operations can be performed by continuation of the insufflation technique of oxygen and sevoflurane or TIVA (propofol 10–20 mg·kg⁻¹·hr⁻¹ and alfentanil 20–30 mcg·kg⁻¹·hr⁻¹) with spontaneous respiration of oxygen enriched air. Alternatively apnoeic oxygenation can be employed. Muscle relaxants are given, anaesthesia is maintained by TIVA and a small tracheal tube is passed for ventilation with oxygen. When the surgeon is ready, the tracheal tube is withdrawn and surgery proceeds until ventilation is needed. Repeated interruptions to surgery and trauma from repeated intubations are disadvantages of this approach. Venturi jet ventilation delivers gas intermittently using an 18 or 16 gauge needle attached to the suspension laryngoscope or placed in the trachea. With each delivery, surrounding air is entrained, increasing the volume and reducing the pressure of gas reaching the patient's lungs. Inflation pressures of approximately 120 kPa at the needle tip are reduced to 30 cm H2O in the mid trachea, which results in visible chest movement. TIVA and muscle relaxants are given. The cannula must be aligned with larynx and the glottis must be unobstructed at all times. Barotrauma and gastric distension are recognised complications. High frequency positive pressure ventilation using a transglottic or percutaneous transtracheal catheter driven by specific jet ventilation can be used in children. TIVA with muscle paralysis is required to ensure a clear glottis.

**Laryngomalacia** may require an aryepiglottoplasty, redundant mucosa is trimmed from the arytenoids and the aryepiglottic folds with the aim of stopping the arytenoids being drawn into the glottic opening on inspiration. Surgery can usually be performed using insufflation anaesthesia with a naso-tracheal tube withdrawn into the pharynx.

**Supraglottic cysts** arise from the vallecula and are normally single. Relaxants are avoided as the cyst may act as a ball valve, making controlled ventilation impossible. The laryngeal inlet is usually posterior to the cyst, but the glottic opening may be hard to visualise in patients with large cysts, where bubbling associated with air movement may be the only clue. Needle aspiration of the cyst may assist visualisation and permit intubation.

**Sub-glottic stenosis** (SGS) usually presents with stridor and may be ‘soft’ with multiple small cysts apparent just below the vocal cords or ‘organised’ SGS when fibrosis results in concentric narrowing. The degree of narrowing is classified according to the Meyer-Cotton system. Endoscopic repair may be attempted in Grade I and II lesions. In ‘soft’ SGS de-roofing of the cysts with cupped forceps is performed to relieve the obstruction, whilst radial cuts supplemented by balloon dilatation are used for ‘organised’ SGS. The airway may be very difficult to maintain as the sub-glottis tends to close in the absence of CPAP. These patients are often well served by intubation using a fine (1.5 or 2.0 mm) Cole Neonatal Resuscitation Tube, which allows a suitable plane of anaesthesia to be achieved. Thereafter the tube may be withdrawn to permit surgery; intermittent re-intubation may be needed. Insufflation anaesthesia with a volatile agent, spontaneous respiration and a nasopharyngeal airway is indicated. Inflation of the balloon in the sub-glottis results in complete airway obstruction and the maximal inflation time should be 30 -45 seconds allowing ample time for recovery before repetition.

**Squamous papillomatosis** caused by the human papilloma virus (HPV types 6 and 11) gives rise to cauliflower like lesions normally arising from the vocal folds but which may be present throughout the tracheo-bronchial tree. Recently, the microdebrider has been used for their removal but standard treatment involves the use of the CO2 or Potassium Titanyl Phosphate (KTP) lasers. The choice of anaesthesia technique will depend upon the clinical status of the patient, and local surgical and anaesthetic preferences. Good topical anaesthesia is essential and analgesia is provided by intravenous paracetamol (15 mg/kg max 1G) with an NSAID if indicated. Codeine (1mg/kg) may be prescribed as rescue analgesia.

**Sub-glottic haemangioma** may on first inspection appear similar to SGS with significant airway narrowing. The haemangioma is usually soft and compressible, distinguishing it from SGS. Open surgical excision by anterior crico-laryngotomy is managed in a similar manner to single stage
Laryngotracheal reconstruction. The recent recognition that beta-blockade causes regression of haemangiomas has revolutionised treatment of this condition.

**Laryngeal cleft** is a deficiency of the posterior wall of the larynx which prevents competent glottic closure when swallowing; children present with a history suggestive of recurrent aspiration. The cleft may extend a variable length into the trachea, but interarytenoid or partial cricoid clefts can be repaired endoscopically. A flexometallic orotracheal tube is used with muscle relaxants, IPPV and a volatile agent. The suspension laryngoscope allows surgical access to the posterior larynx.

**Open operations on the larynx and trachea**

*Anterior Cricoid Split* is an operation used in children with SGS, often those unable to be extubated in the PICU, but who are otherwise well with no pulmonary disease. The first and second tracheal rings are divided in the midline anteriorly. Anaesthesia with tracheal intubation, a muscle relaxant, opioid and IPPV by hand is appropriate. Following the split a naso-tracheal tube of a larger size is passed with the tube tip position just distal to the lowest divided ring; this acts as a tracheal stent for 5 – 10 days. Patients are cared for in the PICU where meticulous attention to the tracheal tube is needed. Blockage or accidental extubation are very hazardous, as attempts at re-intubation can result in the bevel being pushed through the anterior tracheal wall, creating a false passage. Should extubation occur, naso-tracheal re-intubation should not be attempted in the PICU as the angle of tracheal tube passing through the larynx from the nose encourages anterior perforation through the surgical division. The airway should be supported with a mask, oxygenation ensured and oro-tracheal intubation should be attempted. Afterwards the patient can be returned to theatre for naso-tracheal intubation in controlled circumstances. At 5-10 days extubation is attempted using steroid cover.

*Laryngotracheal reconstruction* involves a similar approach to the cricoid split, but instead opens the larynx anteriorly and posteriorly if required. Harvested rib cartilage is interposed into the anterior and posterior split thereby increasing the diameter of the airway. If performed as a single stage procedure, with no covering tracheostomy, the anaesthetic and PICU considerations are the same as those for the cricoid split, including the caveat regarding re-intubation. If a posterior graft is needed a sterile cuffed flexometallic tracheal tube is placed by the surgeon in the trachea distal to the graft site; ventilation is continued in this manner until just before the anterior graft is ready to be placed. At this point a larger nasotracheal tube is passed with the tip positioned just below the graft site by the surgeon under direct vision. Wet neurosurgical patties can be used to pack around this tube to create a seal for IPPV. The patient is returned to the PICU for care as described above. Patients tolerate nasotracheal tubes well and after the first 24-48 hours only minimal sedation is needed. Laryngotracheal reconstruction is also performed as a two stage procedure. The child will have a tracheostomy through which anaesthesia is induced; maintenance is with an opioid, muscle relaxant and volatile agent. To manage the airway, a cuffed flexometallic tracheal tube is inserted through the tracheostome; after which the anaesthetist should check for equal ventilation. The tube is secured by surgical suture just below the tracheostome and fixed to the chest away from the side of rib harvesting using a sterile clear dressing. Care is needed during the operation as surgical manipulation can move the tube resulting in extubation or bronchial intubation; the cuff can also be pierced by suturing. Should this happen the surgeon will need to assist with tube positioning and wet neurosurgical patties will create a seal if the cuff ruptures. A stent is placed in the trachea to support the grafts, after which the anterior larynx is closed. The flexometallic tube is removed after careful tracheal suctioning, a tracheostomy tube is re-inserted and the patient is awoken to be returned to the ordinary ward.

*Cricotracheal resection* involves Short segment tracheal resection for Grade III and IV sub-glottic stenosis. The patient will already have a tracheostomy and the approach to anaesthesia is the same as the two stage laryngotracheal reconstruction. A segment of trachea is excised and a new cricotracheal anastomosis is made. Difficulties with the temporary cuffed flexometallic tube are even more likely in this operation.