Management of the difficult airway in children

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Airway management and endotracheal intubation in children usually present no difficulties for the experienced anaesthetist. In infants, access may be slightly more problematic because of certain anatomical variations: the tongue is large relative to the mandible and the larynx is more cephalad than in the older child. In infants below the age of four months the epiglottis is at the level of the first cervical vertebra; at six months it has moved down to the level of the third cervical vertebra. Unlike the epiglottis in adults, the epiglottis in infants is hard and narrow and is folded into an inverted U shape. These features together give rise to what many people refer to as the 'anterior larynx', but in fact are just due to the relative macroglossia and the higher placement of the larynx. The anatomical variations between infants, children and adults should be easily overcome by use of straight-bladed laryngoscopes which can pick up the epiglottis and reveal the larynx.

The children who present major difficulties for the anaesthetist are not easily missed. In this paper I focus on congenital causes. Others are retropharyngeal abscess, burns, trauma and Still's disease.

PATIENT CHARACTERISTICS

Common craniofacial abnormalities are the Pierre Robin sequence and Treacher Collins and Goldenhar syndromes, but many do not have an eponym.

The Pierre Robin sequence consists of micrognathia and relative macroglossia with or without cleft palate. In the severe case, airway obstruction develops in the first four weeks of life. When the baby is supine the nasopharynx will fill with the tongue (via the cleft palate if present) and cause varying degrees of airway obstruction. Matters become worse if the child struggles and generates a greater negative intrathoracic pressure. These children are best nursed prone, but a tracheostomy may prove necessary. To the anaesthetist the combination of severe micrognathia and relative macroglossia and the cephalad placement of the larynx can make the larynx almost invisible with conventional equipment.

The Treacher Collins syndrome (mandibulofacial dysostosis) consists of abnormalities of the external, middle and inner ear causing hearing loss, mandibular deformities and minor eye abnormalities. Sometimes the facial bones are hypoplastic (usually the zygoma and mandible). These children may also have macrostomia, with or without a cleft or high arched palate, and abnormal dentition. The Goldenhar syndrome (oculoauriculovertebral dysplasia) consists of eye anomalies and ear defects which may again result in hearing loss. Many children with this syndrome have micrognathia and a cleft palate, and there may be unilateral mandibular hypoplasia. In addition, 40% have vertebral anomalies in the form of a Klippel–Feil anomaly. Both these craniofacial syndromes present major airway difficulties similar to the Pierre Robin sequence, and in children with Goldenhar syndrome and associated Klippel–Feil anomaly there is the added problem of a short immobile neck[1,2].

The mucopolysaccharidoses (such as Hurler's, Hunter's and Marateaux–Lamy syndromes) are hereditary progressive disorders in which deficiency of an enzyme results in excessive intralysosomal accumulation of glycosaminoglycans (mucopolysaccharides). The effects make anaesthesia and airway management extremely hazardous[3,4]. These patients develop progressive generalized infiltration and thickening of the soft tissues. The oropharynx becomes obstructed by a large tongue with or without tonsillar hypertrophy. The nasal airway becomes progressively narrowed by thickening of the mucous membranes, adenoidal hypertrophy and redundant 'granulomatous' tissue. The neck is typically short and immobile and the temporomandibular joints may be involved; sometimes the cervical spine is unstable. The supraglottic and infraglottic regions thicken progressively and thus intubation becomes more difficult with age. The age when children with different types of mucopolysaccharidoses become difficult to manage varies greatly and there is variation within each syndrome category. In general, children with Hurler's, Hunter's and Marateaux–Lamy syndromes present the major challenge. A child with Hurler's syndrome may prove difficult or impossible to intubate from as early as two years of age. These syndromes are all progressive and the patients who reach adult life (e.g. those with Hurler–Scheie or Morquio syndrome) will present a severe challenge to the anaesthetist.

ANAESTHETIC APPROACH

Anaesthetic management of children with any of the above conditions should always include a full and frank discussion of risks with parents (and child if appropriate). The

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possibility of tracheostomy and, indeed, of failure to secure the airway should always be mentioned.

In adult anaesthetic practice an awake technique will often be employed, but this cannot be done in children since cooperation is required to gain good bronchoscopic views. What are the essential components of the general anaesthetic approach in children? Atropine premedication should be administered to dry up secretions, then oxygen should be given with either halothane or sevoflurane, by a spontaneously breathing method. Muscle relaxants should be withheld until the airway is secure. Intubation should be performed under deep inhalational anaesthesia. Use of a muscle relaxant during induction of anaesthesia may result in a situation where the anaesthetist can neither manually inflate the patient's lungs nor intubate, and must therefore gain a surgical airway rapidly. Maintenance of spontaneous breathing allows the anaesthetist a way out should the airway prove impossible to secure.

After inhalational induction of anaesthesia, the aim is to attain anaesthesia deep enough to allow visualization of the larynx with a laryngoscope. Should this prove not possible for whatever reason, the anaesthetist must have a plan of how to proceed. This may be to abandon the procedure if the surgical need is not pressing, but if the procedure is essential then alternative means must be available to aid endotracheal intubation. In these groups of patients, although certain manoeuvres using conventional equipment can sometimes succeed, fibreoptic intubation techruques are often necessary.

FIBREOPTIC BRONCHOSCOPES USED IN PAEDIATRIC PRACTICE (Figure 1)

Adult bronchoscopes

Adult fibreoptic bronchoscopes (e.g. Olympus LF2) have an outer diameter of around 3.5–4.0 mm and thus can take realistically a size 4.0–4.5 endotracheal tube loaded onto them. This limits their use in patients less than one year of age, should a simple railroading technique be employed, but the advantage of these scopes is that they have a suction channel to clear troublesome secretions.

Ultrathin bronchoscopes — Olympus LF-P

Ultrathin fibrescopes (such as Olympus LF-P) have an outer diameter of roughly 2.2 mm so a 2.5 mm endotracheal tube can be railroaded over them. The optical quality of these scopes is superb but it should be noted that the LF-P has no suction channel and secretions must be aspirated with a normal suction catheter. The LF-P can be more difficult to control than the larger bronchoscopes and much practice is required if it is to be used for difficult intubations. It is also a delicate piece of equipment, easily damaged.

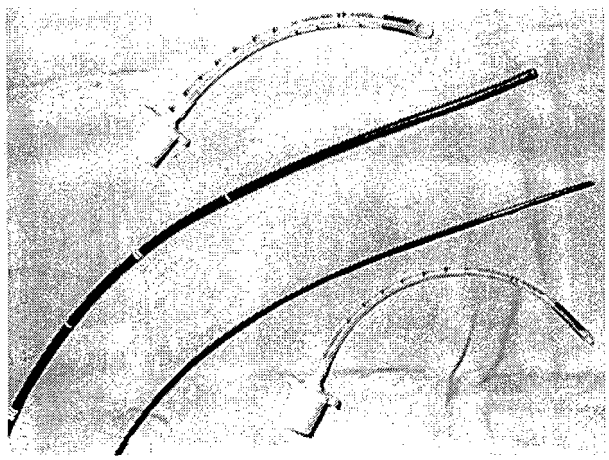

Figure 1 Fibreoptic bronchoscopes used in paediatric anaesthetic practice. The larger scope is the Olympus LF2 and is placed beside a 4.5 endotracheal tube. The thinner scope is the Olyrnpus LF-P and is placed beside a size 2.5 tube

FIBREOPTIC INTUBATION TECHNIQUES

When one opts to use a fibreoptic bronchoscope for intubation, the first requirement is to keep the airway clear, by some means, to allow the anaesthetist time to visualize the larynx. Secondly, an endotracheal tube must be introduced into the trachea. This may be achieved by loading the tube onto the fibrescope and railroading the tube into the trachea, but if the size is wrong the airway may be traumatized. An alternative technique employs a guidewire and this is discussed below. A guidewire technique allows the anaesthetist to use the more robust and more easily guided adult-sized bronchoscopes.

Nasal route

The nasal route is favoured in adult practice and can be used successfully in children. In my own practice, the nasal route is used only if access to the mouth is impossible. Although the angles to the larynx are said to be easier when the scope is introduced through the nose, nasal bleeding caused by the scope or the tube can be very troublesome, especially in patients with mucopolysaccharidoses.

Oral route

With use of the oral route the airway can be preserved by many different methods. Anaesthesia can be maintained via a nasal airway or via a specially adapted facemask. The bronchoscope can then be inserted into the mouth and the larynx visualized. The laryngeal mask airway can also be used. Use of this device in anaesthetic practice can avoid the need for intubation[5], but should intubation be deemed necessary it provides a superb airway, both to maintain anaesthesia (freeing the anaesthetist's hands) and as a

conduit for the fibrescope to view the larynx. The laryngeal mask airway is applicable in almost all paediatric patients with a difficult airway and is an excellent tool to aid visualization of the larynx and entry to the trachea[6].

Intubation through laryngeal mask airway

For endotracheal intubation through the laryngeal mask both blind and fibreoptic guided techniques have been described.

Blind techniques

Blind techniques are possible with either a gum elastic bougie or an endotracheal tube[7]. The published success rate varies and in my opinion these techniques should be avoided in patients with a difficult airway, because of the risks of trauma.

Fibreoptic guided techniques

Fibreoptic techniques depend on adaptation either of the laryngeal mask airway (split[8] or shortened[9]) or of the mode of endotracheal passage (telescoping the tube over the fibrescope[10] or a wire technique[11]). Telescoping (Figure 2) involves pushing the tube of choice onto a larger one which acts as a holding device allowing the anaesthetist to remove the laryngeal mask airway and fibrescope without accidentally pulling out the endotracheal tube. Shortening the laryngeal mask airway and splitting are other methods to the same end allowing the anaesthetist to advance the endotracheal tube through the laryngeal mask airway which can then be removed without hazarding the tube. The technique that I personally favour involves a wire (Figure 3). The guidewire technique allows the anaesthetist to insert a conventional adult fibreoptic bronchoscope to gain a view of the larynx and use the suction facility (lacking in the ultrathin bronchoscopes). The suction channel can then be employed to facilitate passage of a long guidewire into the trachea. This avoids the need to preload an endotracheal tube onto the fibrescope and railroad the tube into the trachea through the laryngeal mask airway—a difficult procedure, and even then the laryngeal mask airway must be removed to allow proper fixation of the tube.

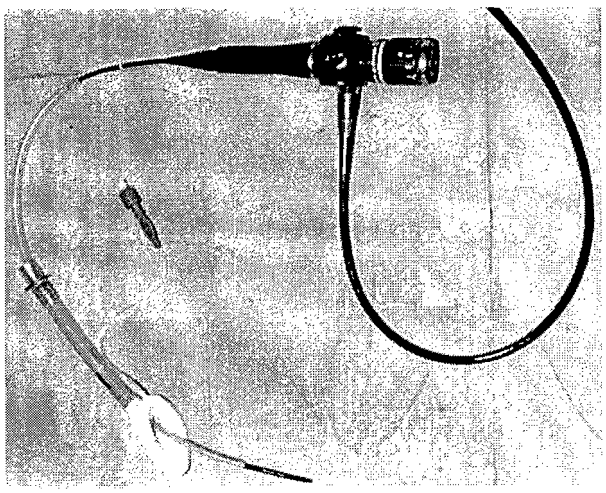

Figure 2 'Telescoping' of the endotracheal tubes over the fibreoptic bronchoscope through the laryngeal mask airway

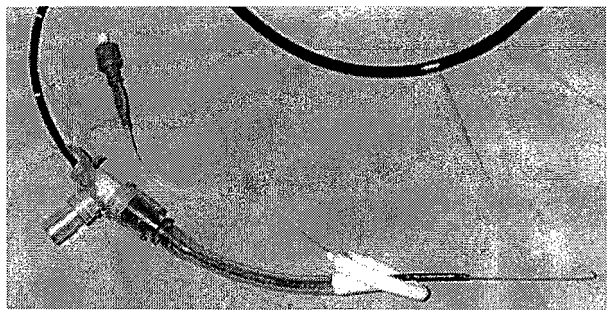

Figure 3 Guidewire technique. An extra long J-tipped guidewire is emerging through the suction channel of the fibrescope, which in turn has been guided through the laryngeal mask airway into the trachea

When the patient is breathing deeply, spontaneously, on sevoflurane or halothane, the fibreoptic bronchoscope is introduced into the laryngeal mask airway until a view of the cords is obtained. Lignocaine 2–3 mg/kg is sprayed via the suction channel of the fibreoptic scope onto the cords. The fibreoptic scope is manipulated through the cords into the trachea until the bifurcation of the trachea is visible. A long J-tipped guidewire is then inserted via the suction channel into the trachea and the fibreoptic scope is carefully removed. If the child's trachea is deemed too small for the fibrescope, the fibreoptic scope will simply sit above the cords and the guidewire is inserted through the cords under direct vision down to the carina and beyond.

A 'stiffening' device is then railroaded over the guidewire through the laryngeal mask airway. The stiffening devices are either a ureteric dilator or a Cook airway exchange catheter. Once these are in place the guidewire is removed and the position of either the ureteric dilator or the airway exchange catheter is verified by capnography. Only after a successful CO_2 trace is obtained is the laryngeal mask airway removed and a tracheal tube of appropriate size railroaded over the stiffening device.

CONCLUSION

Fibreoptic intubation should not be undertaken lightly in children. The laryngeal mask airway not only provides a good airway in a difficult paediatric patient but also can be effective when used as an aid to fibreoptic intubation.

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