Assessment and management of the predicted difficult airway in babies and children

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Abstract

Although it is essential to take a history and examine every child prior to airway management, preoperative anticipation of a difficult airway is not totally reliable and therefore it is wise to be prepared for the unexpected difficult airway. Information about the airway can be gained from previous medical records, current history, physical examination and other tests. A natural consequence of airway assessment is development of an airway plan. Important anatomical and physiological features may be identified in an airway assessment which can then have a direct influence on the subsequent airway plan. Managing the predicted difficult airway is usually elective. This allows proper preparation of equipment, assistants, expertise and the environment required for the airway plan. This paper will discuss paediatric airway assessment, outline those features which contribute to airway difficulty, and identify indications and risk factors associated with various airway techniques. Key objectives for an airway management plan are to maintain oxygenation and avoid trauma. This involves adopting techniques that avoid hypoxia and provide a high success rate with minimum attempts.

Keywords Airtraq®; C-Mac®; difficult airway; difficult intubation; fibreoptic bronchoscope; Glidescope®; paediatric; supraglottic airway devices; TrueView®; video laryngoscope

Royal College of Anaesthetists CPD Matrix: 1C02, 2A01, 2D02

Learning objectives

After reading this article, you should be able to:

- identify a child with a predicted difficult airway
- formulate a clear plan for the management of a child with a difficult airway
- know which equipment is available, and appropriate, for use in managing the difficult paediatric airway

Infant anatomy and physiology

There are a number of key differences between the anatomy and physiology of the paediatric and adult airway and respiratory system (Tables 1 and 2) that have major implications for airway management in the paediatric population.

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Prediction of the difficult paediatric airway

A history and examination help predict the difficult airway and planning for the unexpected difficult airway. Paediatric airway difficulty is commonly caused by functional airway problems. This group includes children with laryngospasm, aspirated foreign bodies, tonsil hypertrophy, poor head positioning, bronchospasm and muscle rigidity secondary to opioids.[1]

The use of bedside screening tests that rely on fixed endpoints, such as the thyromental distance test, are problematic in the paediatric age group, where age ranges from newborn to teenager. Uncooperative behaviour and poor compliance with instructions can render the Mallampati test inaccurate and unreliable in small children.

Knowledge of normal airway anatomy and an understanding of congenital airway anomalies are essential aspects of safe paediatric airway management. For example, ear abnormality could suggest a defect in the embryonic development of the first branchial arch, giving rise to micrognathia and airway management difficulty. Predictors of a difficult airway include a high Mallampati score, limited mouth opening, dysmorphic features, micrognathia, retrognathia, inability to prognath, poor dentition and decreased neck mobility. Signs of airway compromise include tachypnoea, stridor, use of accessory muscles, weak or absent cry, and a history of sleep apnoea or difficulty with breathing during feeding.

Children with facial abnormalities will usually have undergone a range of investigations; results will impact both on the anaesthetic management as well as the plans for postoperative care. These will include imaging (CT and MRI) and nasopharyngoscopy. Sleep studies may highlight abnormal sleep patterns and obstructive sleep apnoea.

Congenital airway anomalies are relatively rare with a prevalence ranging between 1 in 10,000 and 1 in 50,000 live births. These conditions have varied aetiology including genetic, infectious, neoplastic and environmental causes (Tables 3 and 4). Congenital anomalies can affect any part of the airway and may compromise respiratory function at multiple levels. They are frequently associated with anomalies from other organ systems, including cardiovascular, gastrointestinal and central nervous systems. Maturity may also have an impact on the airway. Children with Treacher Collins syndrome, for example, become more difficult to intubate with age, whereas Pierre Robin syndrome improves with age. Relying on past history to anticipate airway difficulty can be unreliable in these patients.

The following definition is taken from the Canadian Airway Focus Group guidelines.

Anatomical features of the paediatric airway

	Infant	Practical implications
Head	Large in proportion to the rest of the body	Head positioning for intubation
Oral cavity	Grows in first year with mandible and teeth growth	Accounts for infant intubation difficulty
Face	Proportionally small in neonates due to absent paranasal sinuses	
Tongue shape	Neonatal tongue is flat with minimal lateral mobility	
Tongue size	Large relative to small oral cavity	Obstruct early, oral airway useful
Larynx appearance	Cephalad anterior, loosely embedded in surrounding structures	Easily moved with external manipulation
Larynx position	Neonates (C2/C3), descends to C5 after 2 years	
Larynx shape	Conical in neonates, cylindrical in older child	
Vocal cords	Shorter in neonate (50% of anterior glottis), 66% in older child	
Epiglottis	<4 months level C1—3. Long, floppy, narrow and omega shaped >6 months level C3—4 (cf. adult C3—6) Hard and narrow in older patients Large and omega shaped	Straight-bladed laryngoscope useful
Narrowest part of airway	Cricoid ring in child cf. laryngeal inlet in adult glottis	
Hyoid bone	Prominent	Easily mistaken for thyroid cartilage
Cricothyroid membrane	Small (neonate 2.6 × 3.0 mm)	Difficult cricothyroidotomy Surgical cricothyroidotomy with tracheal tube contraindicated
Cricoid ring	Functionally narrowest part of neonatal airway Ellipsoid shape, mucosal layer susceptible to trauma	
Trachea length	5 cm in newborn, 8 cm at 1 year, 0—2 years 5.4 cm, 2—4 years 6.4 cm, 4—6 years 7.2 cm, 6—8 years 8.2 cm	Bronchial intubation more common
Carina	T2 in newborn and T4 at 1 year	

From birth to adolescence, tracheal length doubles, tracheal diameter trebles and tracheal cross-sectional area increases sixfold.

Table 1

A difficult airway can be defined as one where an experienced provider anticipates or encounters difficulty with any or all of facemask ventilation, direct or indirect (e.g. video) laryngoscopy, tracheal intubation, supraglottic device use, or surgical airway.[2]

Airway assessment should include every aspect of the airway. If more than one aspect of airway management is concerning, the risk increase and an appropriate airway plan should be designed.[3] Appropriate equipment and assistance needs to be in place and the team need to be aware of the airway plan. A difficult intubation trolley should always be immediately available (Table 5). Lists of recommended equipment for the anticipated and unanticipated difficult intubation in children have been produced. Specific equipment lists can also be devised depending on local preference and requirements. Equipment choice is based on the principles of standardization (to avoid

Physiological features of the paediatric airway

High metabolic rate, 7—9 ml/kg/minute	Rapid oxygen desaturation with apnoea or obstruction
Closing capacity relatively high	Rapid oxygen desaturation with apnoea or obstruction
Functional residual capacity (FRC) low	Rapid oxygen desaturation with apnoea or obstruction
Diaphragmatic breathers	Diaphragmatic splinting will compromise ventilation

Table 2