Microcuff endotracheal tubes versus uncuffed endotracheal tubes in paediatric anaesthesia – a review of the literature

by

Helen Trainor

Trainee Anaesthetic Technician
Introduction

For years there has been an ongoing debate about which type of endotracheal tube provides a better airway in the paediatric patient. I have decided to review the literature and make comparisons about the advantages and disadvantages of uncuffed and microcuff endotracheal tubes used in paediatric anaesthetic practice.

Adult cuffed endotracheal tubes of a smaller size are not used on paediatric patients because of the differences in airway anatomy. Infants have a relatively large head, short neck, and large tongue. The larynx is higher in the neck (C3-4) than in the adult (C5-6) and is placed more anteriorly. The epiglottis is large, floppy and U-shaped. The narrowest part of the airway in an adult is the level of the vocal cords, and in a paediatric patient it is the level of the cricoid cartilage. If an adult endotracheal tube were to be used in an infant the cuff would sit at the level of the cricoid cartilage, which is the narrowest point, so when the cuff was inflated it would immediately cause damage to the cricoid and trachea (Allman & Wilson, 2011).

Advantages of uncuffed endotracheal tubes

Uncuffed endotracheal tubes have been used in paediatric anaesthesia for the last five decades. They are plastic disposable tracheal tubes made of polyvinyl chloride (Al Shaikh & Stacey, 2007). The recommendations have been that uncuffed tubes should be used in children up to 8-10 years, because this is when the airway develops to that of an adult, when the larynx transforms from being cone-shaped to cylindrical (Aitkinhead & Smith, 1998). Advantages of uncuffed tubes are that the presence of an air leak ensures the tube is not compressing the tracheal mucosa
against the non-distendible cricoid ring which may result in mucosal pressure
damage - this also negates the need to monitor cuff pressures for obvious reasons;
uncuffed tubes are self sealing at the point of the cricoid cartilage, so when the
correct size is used, it should prevent aspiration of gastric contents; the absence of a
cuff means that larger tube diameters can be used which facilitates easier succioning
of secretions and lowers the resistance in spontaneous ventilation (Al-Shaikh &
Stacey, 2007). Finally, uncuffed endotracheal tubes are also a cheaper option which
is an important consideration in public hospitals in particular.

Disadvantages of uncuffed endotracheal tubes

Inappropriate tube sizing causes unnecessary interference with the child’s airway.
If the tube is too large it may cause trauma to the airway on insertion and pressure
injury to the tracheal mucosa. On the other hand, if the tube is too small, the work
of breathing is increased and there is the added risk of aspiration and environmental
pollution. Pollution affects the whole theatre team and results in increased
anaesthetic costs due to the requirement for additional oxygen and volatiles to keep
the child adequately anaesthetised.

Weiss (2007) reports an intraoperative tube exchange rate of up to 28% for
uncuffed tubes, which is high. This poses a risk because tubes are exchanged during
the surgical procedure increasing risks such as losing the airway after extubating the
original tube, laryngospasm and trauma from multiple intubations. A large study by
the Zurich group (2009) involving 2200 intubated paediatric patients revealed the
tube exchange rate to be 2.1% with microcuff endotracheal tubes, and 30.8% in
uncuffed tubes (BJA, 2009). This supports earlier discussion about uncuffed tubes having a higher exchange rate, potentially leading to further complications.

It is often assumed that the deliberate leak in an uncuffed tube prevents pressure injury to the airway, however newer investigations by Weiss 2007, have investigated the shape of the cricoid lumen in children and found that it is not circular, but ellipsoidal in shape. If a round uncuffed tracheal tube is inserted into the non-circular lumen to sufficiently seal the airway, considerable pressure on the latero-posterior walls of the cricoid occurs as a result. The air leak at an inspiratory pressure of 20-25 cm H²O, thought to prevent excessive mucosal pressure (Weiss, 2007) may arise only from the anterior part of the cricoid lumen. This is called “cricoid sealing”. With cricoid sealing the pressure exerted on some parts of the cricoid mucosa is not known and may be excessive in spite of an air leak. This is in contrast to “tracheal sealing” where a cuffed tracheal tube with a smaller diameter is selected. This does not wedge within the susceptible cricoid but seals within the trachea using the cuff to create the seal (Weiss, 2007). This results in less trauma to the cricoid lumen. Finally, with uncuffed tubes, the anaesthetist is unable to regulate the tracheal seal in response to respiratory system compliance changes.

With the use of uncuffed tubes there is also an increased risk of micro-aspiration around the tube as well as inaccurate capnographic tracing, spirometric tidal volume measurement and end-tidal anaesthetic measurement because the gas is escaping around the outside of the tube (Bhardwaj, 2009). This gas escapes into the theatre atmosphere and thus polluting it without the ability to analyse it. Also, the leak
around the tube increases the risk of micro-aspiration because if gastric contents enter the laryngopharynx, they can be aspirated into the lungs around the tube leak. In addition to this, micro-leaks increase volatile wastage which further increases the risk of airway fires, volatile costs and OR pollution.

**Advantages of microcuff endotracheal tubes**

In 2004 microcuff endotracheal tubes were invented with improved design over previously used cuffed paediatric tubes. The improved design includes the following features: the cuff was made from polyurethane to allow construction of a very short high volume low pressure cuff with improved sealing characteristics, the cuff is placed more distally than in an adult tube and there is no Murphy’s eye. The benefits of the cuff being more distal are that the tube is placed more reliably below the non-distendable cricoid ring and theoretically reduces the chance of main bronchus intubation (Litman & Maxwell, 2012).

Advantages of using a microcuffed endotracheal tube include a sealed airway preventing aspiration, decreased tube exchange rate, decreased theatre pollution and decreased cost in anaesthetic agents because there is no leak. Sealing with a cuff compensates for different sized and shaped airways and results in more accurate capnography and gas analysis. Tracheal sealing with a high volume low pressure cuff allows the anaesthetist to estimate and adjust precisely the pressure exerted by the cuff on the tracheal mucosa. Pressure monitoring devices are also used to measure pressure and adjust it accordingly. Cuff pressure monitoring devices have been proven to reliably measure cuff pressures and prevent
hyperinflation in cuffed endotracheal tubes (Dullenkopf, Bernet-Buettiker, Maino & Weiss, 2006).

Disadvantages of microcuff endotracheal tubes

The disadvantages of microcuff endotracheal tubes are that extra care is required for correct placement; cuffs can cause trauma if over-inflated; cuff pressure must be monitored throughout the case; smaller tubes limits the ability to suction or ventilate; they are more expensive and they increase work of breathing when spontaneously ventilating. Cuff pressures vary due to temperature, gas exchange, cuff movement and anaesthetic depth. When nitrous oxide is used during anaesthesia, it diffuses into the cuff leading to an increase in pressure inside the cuff and subsequent decrease in the tracheal perfusion pressure (Bhardwaj, 2013). This means that the cuff pressure needs to be monitored regularly throughout the case by the anaesthetic technician. No specific guidelines could be found in the literature stating recommended intervals between cuff pressure monitoring but every half hour would seem reasonable and whenever ventilation modes change or patient position is manipulated.

Conclusion

Ultimately, the type of endotracheal tube that is chosen for a paediatric patient is at the discretion of the anaesthetist, but it is essential as an anaesthetic technician (AT) to be well informed about the benefits and disadvantages of all types of airways. If using uncuffed endotracheal tubes, the AT should be aware of the dangers of pollution in theatre, ensure immediate availability of additional tube sizes in case of
tube exchange and be aware that the capnography and end tidal trace may not be accurate for the patient. If using a microcuff endotracheal tube, the AT should keep in mind that it is essential to inflate the cuff with a pressure monitor to ensure a good seal at an appropriate therapeutic pressure. The cuff pressure should be checked by the AT regularly during the procedure to check that the pressure has not changed, and adjust it accordingly as required. Microcuff tubes are more expensive than uncuffed tubes, however the higher cost is outweighed by savings in tube exchange, anaesthetic and medical gas consumption and the theatre is less polluted with anaesthetic gases.

Endotracheal tubes provide the gold standard of airway protection and paediatric airways are the most delicate of all our patients. The upmost care should be taken to ensure that they are provided with the most suitable endotracheal tube and that no trauma is sustained on their developing airway and lungs (Allman & Wilson, 2011).

References


