Tracheal intubation

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Abstract

Tracheal intubation is the placement of a tube into the trachea. It provides the gold standard for airway protection, ensuring the trachea and lungs are protected from the aspiration of stomach contents. The tube can be used for ventilation, permitting oxygen delivery and the removal of carbon dioxide; it also has a role in delivering drugs. If the tracheal tube is misplaced and this is not recognized, then hypoxia will occur which may be fatal.

Tracheal intubation was first recorded in 1543, but few advances were made until the First World War when its importance was recognized. Sir Ivan Whiteside Magill was predominantly involved in the development of tracheal intubation and he designed several pieces of equipment we still use in our practice today.

Prior to intubating a patient the equipment required should be assembled and checked and the indication for tracheal intubation identified. An experienced trained assistant is required and an anaesthetist with advanced airway skills should be available. Following tracheal intubation, correct placement of the tube should be confirmed by clinical signs and capnography. The tube should be secured to avoid displacement.

Keywords Airway; endotracheal; history; indications; intubation; trachea

Tracheal intubation is the placement of a tube into the trachea. It provides the gold standard of airway control and is the only method which ensures the trachea and lungs are adequately isolated from oesophageal soiling. Oral intubation is where the tracheal tube is passed via the mouth. The tube can also be passed nasally or via an opening created between tracheal rings (tracheostomy).

A failed tracheal intubation, that is where the tube is passed into the oesophagus instead of passing through the vocal cords, if not recognized is potentially fatal, as oxygenation will not take place.

Tracheal intubation permits ventilation through the tube allowing the delivery of oxygen and removal of carbon dioxide. Drugs such as volatile anaesthetic agents and bronchodilators can be given via an endotracheal tube. The tracheal route can be used in an emergency situation for adrenaline administration if there is no intravenous access.

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Learning objectives

After reading this article, you should be able to:

- give an account of the history behind tracheal intubation
- list and explain the indications for tracheal intubation
- understand the principles of tracheal intubation.

History

Tracheal intubation was first reported in 1543. Andreas Vesalius demonstrated endotracheal intubation and artificial ventilation in animals and stated that the technique could be life-saving. However his idea was not developed further for many years.

The first cited oral intubation in humans was performed in 1878 by the Scottish surgeon William MacEwen in a case of laryngeal scalding by a boiled potato. Around the same time Frederich Trendelenburg performed a tracheostomy with tracheal intubation. These were both early and uncommon events.

The technique was further developed and popularized in the early 20th century, principally during the First World War. Sir Ivan Whiteside Magill (1888–1986), an Irish born anaesthetist with an interest in plastic surgery, recognized the potential for tracheal intubation in aiding the delivery of inhaled anaesthetic agents and he played a large part in developing anaesthesia as a specialty. Magill invented a lot of the equipment we still use in anaesthetic practice such as single lumen oral and nasal tubes, endobronchial tubes and bronchial blockers, bobbin flowmeters, the Magill circuit and intubating forceps and catheter mounts. The familiar Macintosh blade was devised by Sir Robert Reynolds Macintosh (1897–1989) and Richard Salt in 1943. The blade was designed when they noted that the Boyle–Davis mouth gag elevates the epiglottis to give a view of the larynx. This blade reduced autonomic response to direct laryngoscopy compared to the Magill blade and was easier to use. Prior to Macintosh and Magill, intubations were performed blindly, using the fingers.

Current practice

Today's practice varies very little from Magill's description over 80 years ago. Most cases of tracheal intubation utilize direct laryngoscopy, where either a rigid metal hand held battery operated laryngoscope or a flexible fibreoptic laryngoscope is used to visualize the glottis. Indirect laryngoscopy uses a small hand held mirror to visualize the glottis and was used in ear, nose and throat (ENT) clinics before the introduction of fibreoptic nasendoscopy.

Indications for tracheal intubation

Definitive indications

Airway protection from oesophageal soiling during anaesthesia:

- gastro-oesophageal reflux
- pharyngeal pouch
- hiatus hernia
- pregnancy (~12 weeks to ~2 weeks post partum)
- emergency surgery
- inadequate fasting time.

Restricted access to the patient or the airway during surgery:
- prone positioning
- neurosurgery
- ENT or maxillofacial shared airway procedures.

Prolonged intermittent positive pressure ventilation:
- intensive care
- respiratory disease
- lung injury
- muscular pathologies.

Airway protection in patients with decreased consciousness (Glasgow coma score <9)
Cardiopulmonary resuscitation
Airway obstruction not relieved by simple airway manoeuvres.

Relative indications

Requirement for intermittent positive pressure ventilation (e.g. due to respiratory failure)
Requirement for muscle relaxation (e.g. open abdominal surgery)
Facial burns and inhalational injury
Obesity.

Contraindications for tracheal intubation

- Inadequate training in intubation or lack of appropriate equipment.
- Airway obstruction by a foreign body above the point where the tube will be passed.
- Severe caution should be observed in patients with cervical spine fractures, where in-line stabilization should be performed in order to prevent spinal cord damage or transection.

Preoperative assessment

A full history and examination should be performed and previous anaesthetic records should be reviewed before anaesthetizing a patient. A detailed preoperative assessment will identify prior airway problems and medical conditions such as rheumatoid arthritis, airway tumours, or previous radiotherapy, all indicating a potentially difficult airway. The majority of patients who have a difficult airway can be predicted clinically by using a combination of bedside tests which includes Mallampati score, thyromental distance, mandibular subluxation, mouth opening, neck extension and sternomental distance. Assessment and management of a difficult airway are covered by a previous article in this series.

Equipment

The equipment used for endotracheal intubation is outlined in Box 1. All equipment should be assembled and checked prior to use and emergency equipment should be available.

Safety

Problems occur not with an inability to intubate the patient but if ventilation and oxygenation fails. It is important to have the knowledge and skills to manage an airway which is difficult to ventilate and/or intubate and to call for experienced senior help early. As long as the patient remains oxygenated then they should remain free from serious harm. Trained assistance should be available for all tracheal intubations and a senior anaesthetist with airway experience should be available when more inexperienced doctors are learning to intubate.

Equipment used for endotracheal intubation

Personal protective equipment — gloves plus visor if the patient is at high infection risk
Monitoring — including capnography, pulse oximetry, electrocardiography and blood pressure
Breathing circuit — Waters circuit or Ambu™ bag, to ventilate the patient with post intubation
Cuffed endotracheal tube of appropriate size — internal diameter e.g. 7.0 mm in a small female, 8.0 mm in a larger female or small male, 9.0 mm in a larger male.
Laryngoscope handle — with batteries
Laryngoscope blade — appropriate for patient, in most cases Macintosh blade (curved blade) size 3 or 4 will be used sometimes a Miller blade (straight blade) is more appropriate
Airway adjuncts — Guedel/nasopharyngeal airways, to aid ventilation
10 ml syringe — to inflate the cuff to 'just seal' pressure; a cuff pressure device is preferable
Water-soluble lubrication — e.g. KY™ jelly or aquagel
Gum elastic bougie — to aid passage of the tube through the vocal cords
Magill forceps — used to guide an endotracheal tube into the larynx
Suction device (Yankauer) — to clear the airway of debris (blood, mucous, saliva)
Stethoscope — to check for proper placement of the endotracheal tube
Tape or a tie — to secure the endotracheal tube in place
Emergency airway equipment — including laryngeal masks, cricothyroidotomy kit and fibreoptic intubating laryngoscope

Box 1

Procedure

The patient should lie supine on a trolley capable of the Trendelenburg position, this is important in case regurgitation of stomach contents occurs during induction of anaesthesia. The patient should have their neck extended with the head comfortably resting on one pillow which elevates the head 8–10 cm. This position allows correct alignment of the oral, pharyngeal and laryngeal axes into the 'sniffing the morning air' position. Optimal positioning reduces the risk of encountering difficulty with airway management. Before induction of anaesthesia preoxygenation with 100% oxygen using a well-fitting facemask is usual practice. Anaesthesia should be induced with a sleep dose of either: propofol; etomidate (sp.); thiopentonal; or ketamine. Following induction, neuromuscular blockade is commonly used to paralyse the vocal cords and facilitate laryngoscopy and intubation, but deep volatile anaesthesia or a combination of propofol and a potent short-acting opiate can also be used.

Tracheal intubation is performed using a laryngoscope of appropriate size held in the left hand. In an average adult with no anticipated problems, a size 3 Macintosh blade is commonly used.

When performing laryngoscopy the scope should be held in the left hand. An appropriate laryngoscope should be chosen such as a size 3 Macintosh blade in an adult with no predicted airway problems. Fully open the mouth and slide the laryngoscope blade down the middle to right hand side of the patient's tongue. Once the epiglottis is seen, and with the tip of the laryngoscope blade resting in the vallecula, lift the scope upwards and away from the patient and the glottis should come into view. Care should be taken not to lever the laryngoscope onto the patient's teeth which could lead to dental damage. If the glottis is seen then the tracheal tube can be passed through the vocal cords into the trachea. The view at laryngoscopy has been graded by Cormack and Lehane, grades 1 and 2 being accepted as straightforward, grades 3 and 4 being very difficult.

Once the endotracheal tube has been passed into the trachea, the tube is connected to a breathing circuit and the patient's lungs are ventilated by hand to confirm correct tube placement. It is important to ensure the tracheal tube has been positioned correctly. This is confirmed by clinical signs and patient monitoring. Fogging of the tracheal tube, bilateral and equal chest movement with ventilation, and equal air entry throughout both lung fields on auscultation are positive clinical signs. Capnography gives a continuous trace of end tidal carbon dioxide and is the most important monitor of correct tube placement. If these are not seen then the tracheal tube may have been passed into the oesophagus and it should be removed and replaced.

Once tube position is confirmed the cuff can be inflated (if this has not been done immediately) to protect the trachea and the tube carefully secured by adhesive tape or a cotton tie using a round turn and a half-hitch knot. ◆

FURTHER READING

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