REVIEW ARTICLE

Nasotracheal intubation for head and neck surgery

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Summary

Nasotracheal intubation offers the head and neck surgeon more scope for surgical manoeuvre in operations of the mouth, pharynx, larynx and also the neck. Concern over the complications of using this route of intubation and lack of training may be limiting its use. A thorough knowledge of the anatomy, benefits of using nasal vasoconstrictors and attention to technique are prerequisites to maintaining the skill. This article reviews each of these topics and aims to encourage the appropriate use of nasotracheal intubation in current practice.

Keywords *Anaesthetic techniques. Intubation, tracheal*: techniques, training, complications. *Surgery*: maxillofacial.

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Kuhn [1] in 1902 was the first to describe the technique of nasotracheal intubation, which he felt was a more physiological approach to tracheal intubation. The technique was further popularised in the 1920s by Magill [2], who preferred this technique for intra-oral surgery. At one time it was popular as a technique for prolonged intubation of patients in the intensive care setting [3], but risk of sinusitis [4] has reduced this use. Similarly, its popularity as an alternative to other techniques during routine anaesthesia has declined. The authors feel that this is predominantly due to a misconception [5] that the technique is traumatic, resulting in increased complications during intubation and increased morbidity postoperatively. Although nasotracheal intubation remains a popular technique during microlaryngeal surgery [6, 7] and dental surgery, we feel that the improved intra-oral access that nasotracheal intubation provides, means that it should be considered for more widespread routine use in the majority of minor intra-oral procedures. Here, we provide an overview of the relevant anatomy, together with the current indications and contraindications for nasotracheal intubation. Recent literature on complication rates, and an outline of anaesthetic techniques and possible training methods are also reviewed.

Nasal anatomy

Normal anatomy

The nasal cavity extends from the anterior nares (nostrils) to the posterior end of the nasal septum where it opens via the posterior nasal apertures (choanae), into the nasopharynx. The floor of the cavity is formed by the upper surface of the hard palate and hence runs in the horizontal plane directly backwards from the anterior nares.

The medial wall of the cavity is formed by the nasal septum, consisting of cartilage anteriorly and bone posteriorly. The bony part consists of the perpendicular plate of the ethmoid superiorly and the vomer inferiorly (Fig. 1).

The lateral wall consists predominantly of the medial wall of the orbit superiorly and the medial wall of the maxillary sinus inferiorly. The lateral wall (Fig. 2) is characterised by the presence of the three nasal conchae (turbinates), which are, in fact, formed from three downward facing scrolls of bone covered by thick respiratory mucosa [8]. The inferior turbinates, invariably the largest of the three conchae, are easily visible on speculum examination of the internal nose (anterior rhinoscopy), where they may be confused for nasal polyps

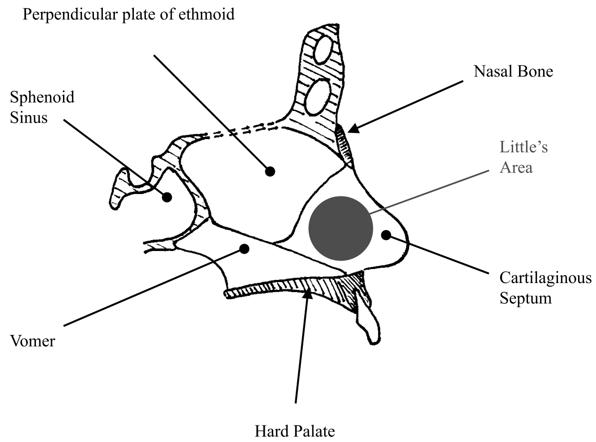

Figure 1 Diagrammatic representation of structures forming medial wall of nasal cavity.

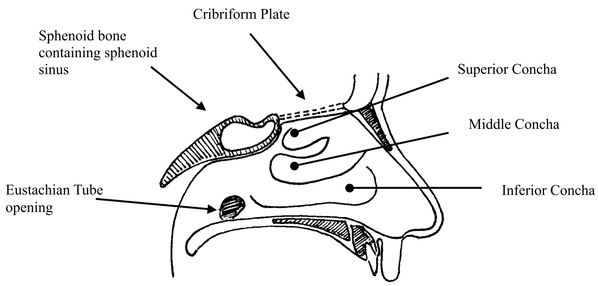

Figure 2 Diagrammatic representation of structures forming lateral wall of nasal cavity.

to the untutored eye. Superiorly, the nasal cavity narrows where the lateral wall and the septum are joined to the narrow cribriform plate of the ethmoid, which separates the nasal cavity from the anterior cranial fossa.

The whole cavity is lined by respiratory mucosa, consisting of ciliated pseudostratified columnar epithelium lying on a highly vascular mucosal stroma, producing both serous secretions for the humidification of inspired air and mucous for the entrapment of inspired particulate matter.

The main blood supply to the nasal cavity is derived from the sphenopalatine artery, a continuation of the maxillary artery. This forms an anastamosis with the superior labial and ascending branch of the greater palatine artery to form Kieselbach's plexus within the anterior part of the nasal septum. This vascular and rather exposed area of mucosa is known as Little's area (Fig. 1), and is the commonest site for spontaneous epistaxis. It is important to note, however, that the nasal mucosa remains well vascularised throughout the nasal cavity, such that trauma to any area can result in brisk bleeding.

Anatomical anomalies

The internal structures of the nasal cavity are rarely symmetrical, and narrowing of the nasal airways may occur for many reasons. The most common anatomical anomaly is septal deviation, which usually affects the anterior, cartilaginous part of the septum, but deviation of the bony septum posteriorly is also not unusual. Although septal deviation is commonly the result of a previous injury, many patients do not give a history of significant trauma, and hence deviation is believed to occur as a result of intra-uterine moulding and trauma during parturition [9]. The presence of septal deviation in foetuses while still *in utero* also suggests a congenital element [10].

Septal deviation changes the airflow dynamics within the nasal cavity causing mucosal changes. Typically, these consist of drying and ulceration of the mucosa on the convex aspect of the septum, and compensatory hypertrophy of the inferior turbinate of the concave side. This means that, commonly, both nasal airways may be narrowed as a result of septal deviation. More severe structural abnormalities are less common and usually occur as a result of more severe trauma or surgery. Other congenital anomalies, such as choanal atresia, are uncommon and are usually diagnosed in early childhood.

Indications for nasotracheal intubation

Head and neck surgery

1 Intra-oral and oropharyngeal surgery
2 Complex intra-oral procedures involving segmental mandibulectomy or mandibular osteotomy and mandibular reconstructive procedures
3 Rigid laryngoscopy and microlaryngeal surgery
4 Dental surgery.

General indications (usually using awake fibre-optic intubation techniques):
1 Intubation of patients with intra-oral pathology including obstructive lesions, structural abnormalities and trismus
2 Intubation of patients with cervical spine instability or marked degenerative cervical spine disease
3 Intubation of patients with obstructive sleep apnoea syndrome

During intra-oral surgery, nasotracheal intubation provides uninhibited access to the mouth, which facilitates insertion of a Boyle–Davis gag or other instrumentation. The surgical field is enlarged, even for routine surgery such as tonsillectomy. The benefit extends to many head and neck procedures including, uvulo-palato-pharyngoplasty, tongue and other intra-oral surgery. It is also the route of choice when performing more complex head and neck procedures using a mandibular osteotomy approach to intra-oral lesions or segmental mandibulectomy for resection of tumours of the floor of mouth and mandible itself [11].

Nasotracheal intubation is preferred for rigid endoscopic procedures particularly when microlaryngoscopy is required. Modified tubes [6, 7] have been designed to improve access to the glottis when required. However, alternative anaesthetic techniques using jet ventilation may need to be employed if access to the posterior larynx is required. In most cases nasotracheal intubation does not impede access to the post cricoid region and cervical oesophagus, during diagnostic procedures. Nasotracheal intubation is a useful technique in patients in whom direct laryngoscopy and orotracheal intubation are impeded, for example, those with trismus due to previous radiotherapy, oropharyngeal infections, decerebrate rigidity or lower facial trauma [12]. In such patients a safe airway may be established using awake fibre-optic intubation. Similarly, intubation may be performed safely using the same technique in patients with cervical spine instability due to trauma or fixed deformity of the cervical spine as a result of degenerative disease or previous surgery [13, 14].

Technique

Pre-operative assessment

As in the case of orotracheal intubation, careful assessment of patients prior to nasotracheal intubation is essential, even though the information gained may be misleading. Aberrations of nasal anatomy are common; nasal septal deviations and septal spurs together with hypertrophy of the turbinates frequently mean that one nasal airway is more suitable for passage of a tube than the other. It is helpful to take a history but evaluation of the patency of the nasal passages by occluding one naris and asking the patient to breathe deeply is not a reliable predictor of the best nostril for nasotracheal intubation [15]. Similarly, the use of anterior rhinoscopy pre-operatively has not been shown to be of benefit [5]. Pre-intubation flexible nasendoscopy can identify asymptomatic intranasal abnormalities. This technique is recommended for the anaesthetist experienced in the use of the fibre-optic laryngocope [16]. In summary, it can be difficult to predict the better naris to choose on the basis of pre-operative testing [17].

Particular attention should be applied to patients who have had previous reconstructive facio-oral surgery especially previous cleft palate repair and pharyngoplasty, in whom it may not be possible to pass a nasotracheal tube. In such patients, pre-operative nasendoscopy is advised if nasotracheal intubation is to be considered [18].

Preparation of the nasal mucosa

The use of lubricating jellies, and topical local anaesthetics and vasoconstrictors such as cocaine solution is widespread. Cocaine 4–10% remains the favoured solution of ENT surgeons, although the studies undertaken have shown that for reduction of bleeding, there is little to choose between it and topical lidocaine 3–4% with phenylephrine 0.25–1% [19, 20], or the imidazoline derivative, oxymetazoline 0.05% [21]. In another study, the application of 10% lidocaine spray 30 mg per naris, 3 min before induction of anaesthesia minimised the increase in mean arterial pressure caused by blind nasal intubation [22]. The potential for cocaine-induced cardiovascular stimulation should restrict application to fit adults and a maximum dose of 1.5 $mg.kg^{-1}$ [23].

Mechanical dilation using incrementally sized nasopharyngeal airways prior to nasotracheal intubation has been advocated as a method for reducing trauma and haemorrhage to the nasal mucosa [24]. However, others have shown this technique to be detrimental, resulting in repeated trauma to the relatively friable mucosa overlying the nasal valve region and significantly more haemorrhage compared with patients intubated without prior mechanical dilation [25].

Choice of tube

Modern preformed nasotracheal tubes are made from synthetic materials of varying stiffness. Warming can make them more supple but at the expense of losing the manufacturer's curve. Cuffed tubes have high-volume, low-pressure cuffs which, when deflated, are more likely to scratch the naris and cause bleeding than the outdated streamlined red rubber cuffed tube. For this reason, many experienced anaesthetists continue to use uncuffed tubes.

Of the PVC tubes available, the Portex Ivory preformed cuffed tube is the most malleable for the nasal passage and yet retains the overall curve that is required for ease of laryngeal intubation [26]. The uncuffed version of this tube, made from polyurethane, is associated with a low incidence of severe nasal bleeding [27].

The diameter of tube that can be inserted via the nasal passage is necessarily smaller than that which can be passed orally. Nasal tubes are also longer. This has implications for ventilation in that small diameter, long tubes increase the pressure differential to flow and therefore the resistance to breathing (Hagen–Poiseuille equation). The range of internal diameter of commercially available nasotracheal tubes lies between 5 mm (for microlaryngoscopy) and 8 mm. Controlled ventilation is essential with a 5 mm tube but spontaneous ventilation for short procedures is practicable in fit adults via a 6 or 6.5 mm tube.

Method of insertion

The well-lubricated tube with fully deflated cuff should be inserted via either naris at right angles to the face. It will then follow the floor of the nose to the posterior nasopharyngeal wall. At this point some resistance may be felt which can usually be overcome by gentle cephalad distraction of the tube and possibly some anticlockwise rotation to present the bevel of the tube to the pharyngeal wall.

Once the tube is beyond the nasal cavity, there are a number of techniques available to advance the tube into the larynx. The method of picking up rubber tubes and catheters in the pharynx with the aid of a forceps and advancing them into the larynx under direct vision laryngoscopy was first described by I W Magill in 1920 [28]. Ten years later, he gave a detailed account of his technique of blind nasal intubation [2]. He wrote, '"Blind intubation" through the nose is, in my opinion, the most valuable manoeuvre in the whole technique.' Nowadays, blind nasal intubation tends to be reserved for situations in which direct laryngoscopy is impossible or where induction of general anaesthesia before neuromuscular blockade would be hazardous. The advent of fibre-optic endoscopy as the gold standard for cases of difficult intubation and the need for training in this specialised technique may further relegate the 'blind' skill [29]. The experienced operator, however, will appreciate the value of blind nasal intubation and continue to use it in daily practice. All skills must be practised in order to be maintained, and this is particularly true of blind nasal intubation.

The advantage of blind nasal intubation over direct-vision advancement for routine intubation is that it can be rapidly achieved whilst avoiding the stimulation of rigid instrumentation. The bulk of the pressor response to laryngoscopy and oral intubation is attributed to laryngoscopy *per se*, whereas the increase in heart rate may be a delayed response [30, 31]. The haemodynamic consequence of nasotracheal intubation assisted by laryngoscopy lasts longer than that for oral intubation and may relate to the necessarily longer duration of laryngoscopy [32]. The response can be attenuated by blind nasal intubation with [22] or without [33] topical local anaesthetic. The hypertensive reaction to intubation is perhaps of little consequence in a young fit patient but in an elderly patient with cardiovascular disease or instability, is better moderated by established pharmacological means rather than through reliance on the effect of topical agents. An additional benefit of nasotracheal intubation without laryngoscopy is that the risk of dental trauma during intubation is eliminated.

Various aids to blind nasal intubation have been employed including: listening to breath sounds directly through the tube or via an extension tube and earpiece [34], inflation of the tracheal cuff [35], the use of stylets/suction catheters [36, 37] and end tidal carbon dioxide monitoring [38]. One of the authors (LES) prefers the technique of gently identifying the right pyriform fossa with the tip of the tube so that the skin visibly bulges. The tube is pulled back slightly, rotated anticlockwise through 90° and then advanced towards the midline and into the larynx. A minor degree of adjustment of the degree of atlanto-occipital extension may be required depending on the curve of the nasotracheal tube. If the tip of the tube is abutting the anterior commissure, flexion of the head on the neck will assist. Where the tube has entered the oesophagus, withdrawal and advancement with the head in a position of increased extension should achieve intubation. Alternatively, the technique of inflating the tube cuff in the pharynx to guide the tip of the tube into the larynx may be as successful [35, 39].

Complications

Epistaxis

The most common complication of nasotracheal intubation is abrasion of the nasal mucosa as the tube is passed posteriorly resulting in epistaxis. This usually occurs from damage to Kisselbach's plexus in Little's area in the anterior part of the nasal septum [12]. This is more likely to occur with the use of an oversized tube, use of excessive force or repeated unsuccessful attempts and possibly if there is inadequate vasoconstriction [5, 40]. If bleeding does occur on insertion of the tube, it is suggested that intubation should be completed, provided it can be accomplished quickly. This will allow the tube to tamponade the bleeding and protect the airway. If tracheal intubation is not satisfactorily achieved in this time, and there is brisk bleeding, the tube may be withdrawn so that the balloon is positioned in the post-nasal space, where it can be inflated to prevent blood passing into the oropharynx while at the same time acting as a nasopharyngeal airway [12]. The incidence of bleeding following nasotracheal intubation reported in the literature is variable [5, 17, 21, 41]. Tintinalli & Claffey [41] reviewed 71 nasotracheal intubations carried out by inexperienced practitioners, under supervision, in an emergency setting. They demonstrated a haemorrhage rate of 17%. However, in only one of these patients was the haemorrhage rated as severe, defined as gross blood suctioned from the mouth or requiring nasal packing. The majority constituted minor bleeding, characterised as a small amount of blood tinged mucous in the oropharynx postintubation. None of the patients in this series had any complications that resulted in significant morbidity or mortality.

Bleeding can also arise from avulsion of nasal polyps, adenoids or tonsils and damage to the posterior pharyngeal wall.

If moderate nasal bleeding persists, effective control can be achieved through the insertion of an absorbent nasal tampon [42] by either the surgeon or the anaesthetist.

Rare complications

This section summarises complications that are rarely described in the literature. Most represent single case reports or complications, which occurred during the development of a technique and equipment. They have been included partly for completeness, but also to highlight potential pitfalls that a good technique and appropriate equipment should avoid.

Traumatic avulsion of structures within the nasal fossa and nasopharynx may occur, most commonly of the inferior turbinate. This has been reported to result in a complete occlusion of the tube [43], and in another case report, the turbinate was deposited in one of the main bronchi [44], resulting in serious ventilatory disturbance. Although avulsion of a turbinate will usually be associated with significant epistaxis during insertion of the tube, epistaxis did not occur in this case. Other structures that have reportedly been avulsed causing obstruction of the tube include the middle turbinate [45], nasal polyps [46], blood clots [47] and tumour [48].

Nasotracheal intubation can be associated with a bacteraemia [49] as a result of abrasion of the nasal mucosa, and carriage of nasal flora into the trachea. Dinner *et al.* [50] measured this in 16% of patients and hence prophylactic antibiotics must be considered where appropriate, for example, in patients with prosthetic heart valves. Posterior pharyngeal wall laceration has occurred as a result of anatomical abnormality [51] and may result in dissection of the retropharyngeal mucosa [52]. One series reported minor lacerations of the posterior pharyngeal wall in 2% of patients undergoing nasotracheal intubation [41]. There is an attendant risk of bleeding and later infection or abscess formation with such a complication. Resistance to the passage of the tube or absence of breath sounds should alert the practitioner to the likelihood that the end of the tube is abutting on the pharyngeal wall. If a pharyngeal wall laceration is identified the authors advocate the use of a broad-spectrum antibiotic to reduce the risk of infective complications.

The following complications have not been reported recently and are possibly of historical interest only. It has been suggested that a tube fitting too tightly through the naris may result in superficial necrosis of the nasal ala, even during short-term intubation [3]. Traumatic nasal intubation can result in oedema around the maxillary ostium or Eustachian duct resulting in maxillary sinusitis and middle ear problems, respectively. In addition, complications have also occurred in the lower pharynx; particularly, in cases in which intubation was difficult requiring repeated passes in order to insert the tube. Structures at risk include the aryepiglottic folds, vallecula, pyriform sinuses and vocal cords. Repeated insertion into the oesophagus has resulted in oesophageal perforation, particularly in conditions in which the oesophageal wall is weakened such as through malignancy or oesophagitis [3].

Overall complication rates

In practised hands or under proper supervision nasotracheal intubation is a safe and useful technique. O'Connell *et al.* [5] used anterior rhinoscopy in 100 patients to demonstrate that within 24 h of nasotracheal intubation there were no visible mucosal tears, although some bruising was visible in 50% of patients, usually around the anterior end of the inferior turbinate and corresponding area of the septum. In addition, none of the patients in this series suffered more serious complications, such as turbinate avulsion, and although the epistaxis rate was 47%, no intervention was required to control haemorrhage. In all cases, blood loss was less than 30 ml. The study by Tintinalli & Caffrey [41] is even more encouraging with a rate of 20% for all complications, mostly cases of mild bleeding characterised by small amounts of blood-tinged mucus only.

Contraindications

Patients with advanced upper airway obstruction having difficulty maintaining their airway are unsafe for any form of awake intubation and require tracheostomy under local anaesthesia or careful inhalational induction of anaesthesia [53].

In the patient with an unimpaired laryngo-tracheal airway, the absolute contraindications to nasotracheal intubation are the patient with, or suspected to have, a base of skull fracture, and the patient with a significant bleeding diathesis. With a base of skull fracture there is obvious risk of penetration trauma through the cribriform plate into the frontal lobes of the brain by the advancing tube [54]. The patient with a clotting factor deficiency, inherited or acquired, has the potential for mucosal trauma to result in severe epistaxis as the tube passes through the nasal cavity.

Anticoagulation, however, appropriately reversed in expectation of routine surgery reduces the contraindication to relative. Practical caution should be observed in any patient taking anti-platelet medication. Patients with rare conditions such as hereditary telangectasia, which may increase the risk of bleeding from the nasal mucosa, are also in this category.

The increased risk of bacteraemia during insertion of the tube makes this technique largely undesirable in patients with known cardiac valvular abnormalities or prostheses.

Blind intubation is contraindicated in the presence of any upper airway foreign body because of the risk of moving the object further distally into the airway, where it may produce more symptoms and be increasingly difficult to retrieve.

Training

Whilst we have outlined a number of pitfalls and potentially serious complications that may occur during nasotracheal intubation, the basic technique is simple and may be performed safely by relatively inexperienced operators under appropriate supervision [41]. The techniques of blind intubation [36, 37] and fibre-optic guidance require more formal training. A study of non-anaesthetically trained graduates of the Advanced Trauma Life Support course asked to perform blind nasal intubation showed a high failure rate [55]. This review strengthens the view that there is no substitute for clinical experience in the performance of this technique.

However, the fibre-optic intubation skill in awake patients was initially enhanced among trainees who underwent a graduated training programme using simulators [56]. Subsequent work has shown that the psychomotor skill of fibre-optic nasotracheal intubation can be further perfected at workshops [57] and through the use of an endoscopic video camera [29].

Surgical opinion

From the surgeon's perspective there are many advantages to nasotracheal intubation. For oropharyngeal procedures, notably tonsillectomy, the surgical field is maximised by the use of a nasotracheal tube. The tube lies inconspicuously in the pharynx remote from surgical manoeuvres. Placement of a Boyle–Davis gag is simpler, and problems of compression or movement of an orotracheal tube as the gag is opened are avoided. Better access, in particular to the base of tongue and inferior aspects of the tonsillar fornices, facilitates haemostasis, although no formal studies have been performed to demonstrate any significant reduction in postoperative haemorrhage.

Nasotracheal intubation facilitates routine rigid laryngoscopy and ensures that all the structures around the base of tongue and epiglottis can be viewed adequately.

All routine diagnostic procedures in the head and neck region should include thorough inspection and palpation of the oral cavity, in particular of the tongue and soft palate, which cannot be performed adequately in the clinic setting. Adequate examination may be hampered by the presence of an orotracheal tube and in addition the tube is at some risk of displacement, as it must be moved by the surgeon in order to perform the assessment.

Conclusions

The authors have reviewed the available literature that describes the role of nasotracheal intubation for head and neck surgery. It is an effective and safe technique that we believe is underused in current practice. It is our personal view that the benefits of nasotracheal intubation to the head and neck surgeon outweigh the potential disadvantages to the patient of using this route of tracheal intubation. Whereas fibre-optic intubation has become an essential skill for anaesthetists dealing with patients in whom orotracheal intubation is anatomically difficult, the use of 'blind' techniques have fallen out of favour. Fibre-optic nasotracheal intubation clearly has an important place in anaesthetic practice, but is expensive in terms of time and equipment required for routine minor ENT or maxillofacial lists. It is in this setting that careful intubation with the aid of forceps or, with training, 'blind' nasotracheal intubation forms a quick and safe alternative for the anaesthetist while providing improved operating conditions for the surgeon.

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