Review

Clinical Application of Nasotracheal Intubation: A Narrative Review

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Clinical Application of Nasotracheal Intubation: A Narrative Review

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Abstract: Nasotracheal intubation is commonly used in clinical practice for procedures requiring general anesthesia, mechanical ventilation, and emergency treatment of critically ill patients. It provides a good surgical field and operating space for maxillofacial surgeries, offers an artificial airway for long-term mechanically ventilated patients in the intensive care unit, and presents a new method for emergency and difficult airway intubation patients. Compared to orotracheal intubation, nasotracheal intubation has advantages such as minimal stimulation to the throat, good patient tolerance, easy fixation, facilitation of oral care, and longer duration of placement. However, it requires higher technical skill from the operator and has a higher incidence of complications like epistaxis and sinusitis, which have restricted its widespread application. From the early blind intubation method to the current direct laryngoscopy, video laryngoscopy, and fiberoptic bronchoscopy, the success rate of nasotracheal intubation has gradually increased while the incidence of complications has decreased. In this review article, we summarize the common methods, advantages and disadvantages of nasotracheal intubation, as well as the research progress on related complications and coping strategies, aiming to enhance the application of this technology in clinical practice.

Keywords: nasotracheal intubation; video laryngoscopy; fiberoptic bronchoscopy; complications; epistaxis; nasal pressure injury; sinusitis

1. Introduction

Tracheal intubation is a routine procedure for rescuing critically ill patients and general anesthesia, with the main purpose of maintaining a clear airway, preventing reflux and aspiration, as well as connecting to a ventilator for mechanical ventilation. Tracheal intubation can be performed by the oral or the nasal route. Orotracheal intubation is characterized by simple and convenient operation, but patients may find it uncomfortable and it is not conducive to oral care. Nasotracheal intubation is more in line with the physiological characteristics of the patient's airway, with advantages such as minimal stimulation to the pharynx, good patient tolerance, easy fixation, convenient oral care, and longer indwelling time. However, it requires a high level of technical expertise from the operator and carries risks of nasal and nasopharyngeal injury, epistaxis and sinusitis. In recent years, with the development of clinical medicine and advancements in research, especially the application of technologies such as video laryngoscopy and fiberoptic bronchoscopy in nasotracheal intubation, the success rate of nasotracheal intubation has significantly improved while lowering associated complications [1]. This article provides a comprehensive review of the research progress on the application of nasotracheal intubation in clinical practice.

2. Indications and Contraindications of Nasotracheal Intubation

Nasotracheal intubation is a frequently utilized technique in the anesthesia of oral and maxillofacial surgery patients, offering improved surgical visibility and operational space compared

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to orotracheal intubation[2,3]. For anterior cervical surgery, patients with nasotracheal intubation do not need excessive neck extension, with the mandibular-cervical angle increased by 7.3°, improving the surgical field[4]. Additionally, for patients with facial trauma, prehospital nasotracheal intubation is also a feasible short-term alternative to orotracheal intubation[5]. In the intensive care unit (ICU), due to complications such as epistaxis and infections (sinusitis and ventilator-associated pneumonia) that may occur with nasotracheal intubation, tracheal intubation is mostly done through the oral route, gradually replacing nasotracheal intubation with orotracheal intubation[6]. However, in the ICU, patients with long-term tube placement are often encountered since the prognosis of these patients is poor, family members are often unwilling to let them undergo tracheostomy. Nasotracheal intubation can be considered for such patients as the duration of orotracheal intubation cannot be too long. For some awake patients in the ICU, the use of nasotracheal intubation can reduce the dosage of sedatives, due to good tolerance, some patients may not need sedatives and can eat orally independently. Furthermore, in patients with respiratory infectious diseases, nasotracheal intubation can reduce the risk of infection during intubation by medical staff. In the pediatric intensive care unit (PICU), the proportion of nasotracheal intubation seems to be higher than in adult patients, with reports of nasotracheal intubation rates in PICU children being 5.6% and 3.8% respectively[7,8]. Another study reported that in cardiac surgery, the proportion of neonates using nasotracheal intubation was 41% and infants 38%[9]. These studies have confirmed that the use of nasotracheal intubation in children is safe, with no significant increase in the risk of serious complications. Compared with orotracheal intubation, the unplanned extubation rate significantly decreases, and the incidence of sinusitis and ventilator-associated pneumonia does not significantly increase.

Bilateral nasal obstruction in patients is an absolute contraindication for nasotracheal intubation. Therefore, the patency of the patient's nasal cavity should be assessed before nasotracheal intubation. Nasopharyngeal hemangioma, severe laryngeal edema, coagulation disorders, skull base fractures, and the possibility of elevated intracranial pressure are relative contraindications for nasotracheal intubation, and such patients should try to avoid undergoing nasotracheal intubation as much as possible.

3. The Choice of Nostril

When nasotracheal intubation is performed, if both nasal cavities of the patient are clear, intubation can be done through either nostril. A study reported that the success rates of intubation through the left nostril and the right nostril are similar (Group L 96% (24/25); Group R 96% (24/25)), with no difference in the incidence and severity of epistaxis during intubation[10]. However, the most current available evidence suggests that intubation through the right nostril is safer and faster, with lower incidence and severity of epistaxis[11–13]. Research has shown that for intubation through the left nostril, angling the tip of the endotracheal tube towards the nasal septum direction can reduce the incidence of epistaxis[14]. A study on 390 patients undergoing nasotracheal intubation found that among 94 patients with nasal septum deviation identified by X-ray, complications significantly increased when nasal septum deviation was present (35.0% vs 18.5%)[15]. Therefore, before nasotracheal intubation, if conditions permit, preliminary assessment of nasal patency through a blockage test can be helpful in selecting the nostril. When both nostrils are patent, we recommended to choose the right nostril for nasotracheal intubation.

4. Equipment and Nasotracheal Intubation Methods

4.1. Tracheal Tube

Tracheal tubes used for nasotracheal intubation generally do not have specific requirements. Choosing a small-sized endotracheal tube compared to oral intubation is beneficial for ease of operation and reducing complications[16]. The Parker Flex-TipTM tracheal tube, with a flexible and soft tip design, can minimize damage to nasal mucosa during intubation. This tracheal tube is advantageous in controlling hemodynamic reactions during intubation, particularly with minimal impact on a patient’s heart rate and diastolic pressure[17,18]. Preheating and softening the tracheal

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tube before intubation can alleviate damage to the nasal mucosa and reduce the incidence of epistaxis[19,20]. A study reported that in 140 cases of nasotracheal intubation patients, the incidence and severity of epistaxis were significantly lower in the heat-softening group compared to the control group (7% vs. 51%)[21]. However, it should be noted that overly soft tracheal tubes may affect the patency of tracheal intubation and impact the success rate of nasotracheal intubation.

4.2. Blind Nasotracheal Intubation

Blind probing was initially utilized for nasotracheal intubation due to equipment constraints, without any auxiliary measures, requiring a high level of technical proficiency from the operator. Trained operators can also achieve a higher success rate. In 1993, van Elstraete et al. reported a success rate of 75% for blind nasotracheal intubation using cuff inflation method, with an overall success rate of 95%[22]. The specific procedure involved inserting the endotracheal tube through the right nostril, positioning the tube tip at the oropharynx, inflating the cuff with 15 ml of gas, gently advancing the tube until encountering slight resistance when the cuff touched the vocal cords, deflating the cuff, and inserting the endotracheal tube into the trachea. Another method is the suction catheter-guided blind nasal intubation, where a suction catheter is first inserted through the nasal cavity into the trachea, followed by sliding the endotracheal tube over the suction catheter and slowly advancing it into the trachea before removing the suction catheter[23,24]. The key step in this method is inserting the suction catheter into the trachea, once achieved, subsequent steps are relatively straightforward. Training operator providers in blind nasotracheal intubation is crucial, with proficient individuals achieving success rates comparable to fiberoptic bronchoscope nasotracheal intubation[25]. Despite being considered outdated, this technique remains a critical option when dealing with special patients such as severe cervical deformities, burns, and those with limited or impossible mouth opening[26].

4.3. Direct Laryngoscopy Nasotracheal Intubation

Since the introduction of tracheal intubation in 1913 and the improvement of the blade by Miller and Macintosh in the 1940s, direct laryngoscopy has been the traditional approach for tracheal intubation. During nasotracheal intubation, with the assistance of direct laryngoscopy, the vocal cords can be visualized, facilitating intubation under direct vision, which improves the success rate compared to blind intubation. With direct laryngoscopy assistance, after the tube enters the nasopharynx, the Magill forceps can be used to guide it into the vocal cords and trachea, reducing the difficulty of nasotracheal intubation and increasing the success rate. Research has shown that using a disposable tube core during nasotracheal intubation can replace the use of the Magill forceps and significantly reduce intubation time without a difficult airway[27]. Therefore, in patients without difficult airways, using a tube core for nasotracheal intubation may be a good choice. Of course, direct laryngoscopy-assisted nasotracheal intubation needs to be performed under direct vision, requires a high level of visibility, patients need to be sedated and anesthetized, and the process of exposing the view may result in significant cardiovascular responses in patients, leading to relatively higher intubation risks. With the advent of video laryngoscopy, this method is gradually being replaced.

4.4. Video Laryngoscopy Nasotracheal Intubation

The introduction of video laryngoscopy has revolutionized the technique of tracheal intubation, significantly increasing the success rate of intubation and reducing the time required for the procedure[28,29]. Currently, video laryngoscopy is widely used for Nasotracheal intubation, gradually replacing direct laryngoscopy. Compared to direct laryngoscopy, video laryngoscopy does not require excessive head extension of the patient, has lower demands on patient positioning, and offers greater convenience[30]. In the ICU, where the majority of intubations are urgent and unplanned, the assistance of video laryngoscopy has been shown to enhance intubation success rates and reduce difficulty in intubation both nasotracheal and orotracheal intubation[31,32]. In emergency and anesthesia settings, the use of video laryngoscopy has been found to enhance first-pass intubation

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success rates and decrease adverse events when compared to direct laryngoscopy[33,34]. For pediatric nasotracheal intubation, HugeMed® video laryngoscopy provides improved vocal cord visualization, reduces the difficulty of nasotracheal intubation, and minimizes tissue trauma[35]. A study involving 50 patients undergoing nasotracheal intubation showed that video laryngoscopy resulted in faster intubation times and reduced use of Magill forceps compared to direct laryngoscopy[36]. McGrath video laryngoscopy is commonly used and has advantages over Macintosh direct laryngoscopy, including reduced airway trauma, faster intubation times, better vocal cord visualization, and overall good intubation outcomes[37,38]. Another type of video laryngoscopy, C-MAC® video laryngoscopy, offers excellent vocal cord visualization for nasal tracheal intubation compared to Macintosh direct laryngoscopy, with high intubation success rates, stable hemodynamics, and reduced incidence of complications such as epistaxis and postoperative sore throat[39,40]. Additionally, the adjustable angulation of the C-MAC video laryngoscope blade has been shown in studies to facilitate faster nasotracheal intubation in patients with cervical injuries, providing better vocal cord visualization and avoiding excessive head extension[41,42]. For awake nasotracheal intubation patients, video laryngoscopy assistance has been found simpler, and faster compared to fiberoptic bronchoscope assistance, and reduces the risk of oxygen saturation dropping below 90% during the intubation process[43].

4.5. Fiberoptic Bronchoscope Nasotracheal Intubation

The fiberoptic bronchoscope nasotracheal intubation procedure involves placing the tracheal tube sheath at the front end of the fiberoptic bronchoscope insertion part, inserting the fiberoptic bronchoscope from the nasal cavity into the trachea, guiding the tracheal tube along the fiberoptic bronchoscope into the trachea. The tracheal tube is into the trachea until it is positioned 2-4 cm from the carina, and then the fiberoptic bronchoscope is withdrawn. The advantages of this method are as follows the entire operation is done under direct visualization, resulting in a high success rate of intubation. It allows for easy control of the intubation depth during the process, precise measurement of the distance between the tracheal tube tip and the carina, and reduces the risk of misplacement into the main bronchi or esophagus. Compared to blind intubation and direct laryngoscopy, fiberoptic bronchoscope nasotracheal intubation significantly reduces the incidence and severity of epistaxis in patients[44,45]. The application of fiberoptic bronchoscope nasotracheal intubation in pediatric dental surgery is also safe, with a higher success rate and fewer hemodynamic reactions and adverse events compared to direct laryngoscopy[46]. Traditional fiberoptic bronchoscopes have a harder texture and are associated with more complications during intubation. In recent years, flexible fiberoptic bronchoscopes have been more widely used for nasotracheal intubation, especially in awake patients, where they have a clear advantage[47–49]. Compared to direct laryngoscopy and video laryngoscopy nasotracheal intubation, oral secretions and bleeding are key factors affecting the success rate of fiberoptic bronchoscope intubation. Efforts to reduce oral secretions and bleeding can improve the success rate of fiberoptic bronchoscope intubation[50]. A drawback of fiberoptic bronchoscope nasotracheal intubation is the cumbersome preparation before intubation, making it suitable for elective surgery patients undergoing preoperative anesthesia intubation, but not applicable for patients requiring emergency intubation.

4.6. Other Nasotracheal Intubation Methods

The lightwand-guided nasotracheal intubation uses the light source at the front end of the lightwand to guide the intubation process. Compared to blind nasotracheal intubation, lightwand-guided nasotracheal intubation has fewer complications, shorter intubation time, and a higher success rate[51]. The specific procedure involves inserting the tracheal tube through the nose into the oropharynx, and then inserting the flexible light wand into the tracheal tube. By adjusting the lightwand guided by the light point on the anterior neck, the light should be positioned just above the cricoid cartilage. The tube is then advanced into the trachea, followed by slow removal of the lightwand. However, repeated adjustments of the lightwand during intubation may pose risks of

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damaging the nasal cavity, epiglottis, or airway. Ultrasound-guided tracheal intubation (UGTI) is a new intubation method that offers certain advantages for patients with limited mouth opening who cannot use a laryngoscope, unaffected by oral secretions or blood[52]. This technology is currently more commonly used for orotracheal intubation, with limited reports on its application in nasotracheal intubation.

5. Complications of Nasotracheal Intubation

5.1. Epistaxis

Epistaxis is a common and serious complication of nasotracheal intubation, usually caused by damage to the nasal mucosa and blood vessels. Continuous and large bleeding may be life-threatening, so efforts should be made to prevent it. Vasoconstriction of nasal blood vessels can reduce the incidence of epistaxis, therefore guidelines recommend the use of local nasal vasoconstrictors before nasotracheal intubation[53]. Pre-emptive epinephrine nebulization is an effective method to prevent epistaxis caused by nasotracheal intubation[54]. A study on the prevention of epistaxis before intubation with xylometazoline spray and epinephrine filling showed that epistaxis during intubation was significantly reduced in the xylometazoline spray group, making it a good alternative to epinephrine filling before nasotracheal intubation[55]. Xylometazoline drops are easier to administer, another study demonstrated that the rate of severe epistaxis was lower in the xylometazoline group compared to the epinephrine group, and epistaxis during extubation was reduced in the xylometazoline group[56]. Both cocaine and xylometazoline are effective in preventing epistaxis after nasotracheal intubation, with no statistical difference between the two groups[57]. Bupivacaine constricts blood vessels at low concentrations and dilates them at high concentrations, and nasal packing with bupivacaine can more effectively reduce epistaxis during intubation[58]. Some scholars have questioned the effectiveness of vasoconstrictor use, stating that good catheter lubrication is key to preventing epistaxis. In cases where tracheal intubation is difficult, the incidence of epistaxis during nasotracheal intubation is 71%, which is reduced to 12% when tracheal tubes are smooth[59]. The use of softer North Polar Tubes can significantly reduce the incidence of epistaxis during nasotracheal intubation[60]. A Gentle operation during the intubation process is crucial for preventing epistaxis, and when encountering resistance during intubation, adjusting the angle and curvature of the tube should be done to avoid the use of force and minimize direct damage to the nasal mucosa.

5.2. Nasal Pressure Injury

Nasal pressure injury is a common complication after nasotracheal intubation, caused by excessive resistance from the tracheal tube to the nasal skin. Risk factors include prolonged intubation time, lack of protection in the nasal wing area, and high body mass index is considered an important protective factor[61]. Research has shown that implementing nasal protection strategies can significantly reduce the incidence of nasal pressure injuries during nasotracheal intubation, specific measures include using protective dressings and improving the fixation method of the endotracheal tube[62]. Yang et al. reported in a study of 450 patients with nasotracheal intubation that protecting the nasal wing skin with hydroactive dressings can significantly reduce the incidence of nasal pressure injuries[63]. Another study in the PICU found that the application of Hydrocolloid dressing in children with nasotracheal intubation can reduce nasal pressure and shear forces, absorb exudate, and provide good nasal protection effects[64]. Fixing the nasotracheal tube with 3M microfoam™ surgical tape can also prevent nasal pressure injuries related to nasotracheal intubation[65].

5.3. Sinusitis

Sinusitis is one of the complications associated with nasotracheal intubation, especially in patients with prolonged intubation, with a higher incidence compared to orotracheal intubation[66,67]. The reason for this is the damage to the nasal mucosa during the intubation process, leading to local edema and sinus ostial obstruction, then contributing to poor drainage of

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sinus secretions. A study on nasotracheal intubation patients in the ICU reported 47 cases of patients intubated for 5 days or more, with 23 cases (49%) developing sinusitis. Therefore, it is recommended that the nasotracheal tube should be removed if it is used for more than 5 days, or if unexplained fever occurs[68]. Sinusitis can also be a late complication. A study of 68 postoperative patients over one year found that in the group with oral intubation, 2 cases showed signs of sinusitis, while in the group with nasotracheal intubation, 15 cases showed signs of sinusitis, indicating a higher incidence of sinusitis in the nasotracheal intubation group[69]. For the prevention of sinusitis during nasotracheal intubation, some scholars suggest the use of 2% nasal mupirocin ointment applied to both nasal cavities and the vestibule of the anterior nasal septum to reduce colonization of Staphylococcus aureus and other Gram-negative bacteria, thereby reducing the incidence of sinusitis[70].

5.4. Other Complications

Sore throat is one of the complications after nasotracheal intubation, caused by the stimulation and pressure of the tube on the throat. The overall incidence of postoperative sore throat related to nasotracheal intubation after oral and maxillofacial surgery is as high as 74.6%[71]. Compared with Macintosh laryngoscope, fiberoptic bronchoscope nasotracheal intubation significantly reduces postoperative sore throat[72]. Cardiac arrest is a serious complication during nasotracheal intubation[73], triggered by the stimulation of nasal mucosa during intubation leading to rhino-cardiac reflex. Once rhino-cardiac reflex occurs, intubation should be stopped immediately, and rapid cardiac drug support should be administered, including atropine, epinephrine, etc. Other rare complications of nasotracheal intubation includes retropharyngeal internal carotid artery injury[74], submucosal retropharyngeal dissection[75], pyriform sinus perforation[76] and cervicothoracic emphysema[77].

6. Techniques to Improve the Success Rate of Nasotracheal Intubation

The success rate and complications are the primary concerns associated with nasotracheal intubation. Addressing these problems is crucial for the success of this technique. Lifting the nasal tip can help guide the tube into the trachea, increasing the success rate of nasotracheal intubation[78], therefore, it is recommended to pull the nasal tip towards the head in a sideways direction when performing nasotracheal intubation, as it is considered a standard procedure for inserting the tube into the nostril. Studies have found that when the nasal intubation tube is directed towards the head rather than towards the left side, positioning it towards the head side of the trachea is more favorable for tube insertion, reducing the incidence of nasal bleeding in patients undergoing jaw surgery during nasotracheal intubation[79]. Prior to nasotracheal intubation, effective nasal cavity expansion is beneficial for guiding the tube into the pharynx and significantly reducing trauma and the incidence of epistaxis during nasotracheal intubation[80]. Placing a nasopharyngeal airway before nasotracheal intubation allows the tube to enter the pharynx through the airway, reducing the incidence of complications such as epistaxis[81,82]. The nasopharyngeal airway provides more stability, prevents collapse of the nasal airway, increases nasal cavity space, reduces the difficulty of tube insertion through the nasal cavity, and improves intubation conditions[83]. Standardized training for operators, selecting appropriate intubation methods, and avoiding the use of force during the intubation process are key factors in improving intubation success rates and reducing complications.

7. Conclusions

In clinical practice, nasotracheal intubation is a valuable airway management technique that offers advantages in specific situations. Operators must have a comprehensive understanding of indications, complications, and the latest advancements in airway management to ensure the safety and effectiveness of airway management. Various methods of nasotracheal intubation have their own pros and cons, and healthcare providers should be proficient in one or more techniques to be able to

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successfully perform nasotracheal intubation when necessary, ensuring patient safety and meeting surgical requirements.

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