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A Safer Technique for Nasal Intubation: A Literature Review

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Abstract

Nasotracheal intubation (NTI) is the most widely used method to establish an airway during anesthesia for oral surgery. It has the advantage of providing exceptional accessibility and optimal working conditions in the oral cavity for surgeons. Anesthesia providers are highly trained in managing and securing the airway. Because the oral intubation route is the most widely used technique for securing the airway, nasal intubation can be cumbersome for anesthetists who do not routinely perform this skill. Moreover, anesthesia providers who do not routinely perform NTI may feel apprehension out of concern for nasopharyngeal bleeding and trauma. The number of dental and oromaxillofacial procedures requiring nasal intubation has been steadily growing annually. Although NTI is generally safe, it still presents a risk for complications. The purpose of this literature review was to examine current literature and evidence-based practices of NTI to determine whether the use of a catheter-guided technique will improve patient care outcomes by way of decreased trauma to the airway compared to current clinical practices. The goal of this review is to recommend the use of a catheter-guided technique for NTI as the preferred method for securing the airway during oral surgery as it is less traumatizing to the airway than conventional methods.

Keywords

Nasotracheal Intubation, Bleeding, Red-Rubber Catheter, Catheter-Guided, Epistaxis

1. Introduction

Nasotracheal intubation (NTI) has the advantage of providing exceptional accessibility as well as an optimal working environment in the oral cavity for the surgeon. Anesthesia providers are highly trained in airway management tech-

niques involving orotracheal and nasotracheal intubations. While NTI is generally safe, it still poses the risk for potential for complications such as nasopharyngeal bleeding and trauma. Other complications that may occur from NTI include: transfer of bacteria from the nasal cavity via the endotracheal tube (ETT), obstruction of the ETT with a foreign object, submucosal laceration, trauma to the middle turbinate, cribriform plate fracture, as well as olfactory nerve damage [1]. To provide safe and exceptional care, anesthesia providers need to address the risks associated with NTI. There are currently no guidelines set in place to train or educate providers on alternative NTI techniques. The objective of this review would be to augment current anesthesia practices by incorporating an alternative NTI technique into practice, resulting in enhanced patient care.

The use of a red rubber catheter-guided technique for NTI was first described in 1979 in a correspondence by MacKinnon and Harrison. The brief report discussed the incidence of trauma during the passage of the endotracheal tube through the nose and pharynx [2]. The authors also elucidated on the incidence of tearing of the mucosa, epistaxis, and contamination of the tube during NTI [2]. A method in which the use of a Jacques red rubber catheter was utilized on the tip of nasotracheal tube was described. In an article by Garside and Hatfield, the technique is described in a succinct and instructive manner [3]. The technique is described as placing an introducer over the bevel of the endotracheal tube, which fits securely but not too taut [3]. After intravenous induction, the nostrils are sprayed with a vasoconstrictor such as oxymetazoline. The catheter is then passed into the floor of the nasal cavity, aiming to pass it below the inferior turbinate. Afterward, the anesthesia provider performs direct laryngoscopy, and the tip of the catheter is visible in the oropharynx; it is retrieved using a Magill forceps and handed to an assistant. The assistant then pulls the catheter through the opening of the mouth while the anesthetist advances the lubricated tracheal tube with gentle yet firm pressure. When the endotracheal tube is visible in the oropharynx, the catheter is gently pulled off, and intubation can proceed as usual [3]. "The essence of the technique is to push the tracheal tube through the nasal passages with its opening covered by the expanded end of the Jacques catheter" [2] (p.911). The objective of the method described is to reduce trauma to the nasal passages, decrease bleeding, and prevent tube contamination [2]. **Figures 1-8** illustrates proper placement of nasotracheal tube utilizing the method described.

Complications as a result of NTI are one of the many contributors to anesthesia-related mortality [1]. Among those complications associated with NTI are: epistaxis, bacteremia, endotracheal tube obstruction, retropharyngeal perforation, mucosal laceration, olfactory nerve injury, turbinate avulsion, and perforation of the pyriform fossa (**Table 1**).

Figures 1-8 Steps of Proper Red-Rubber-Catheter Placement [4].

Table 1. Complications associated with Nasal Intubation [1] [14].

	Possible Complications of NTI
Epistaxis	Mucosal laceration
Transfer of bacteria to lungs	Olfactory nerve injury
ETT obstruction with mucus	Turbinate avulsion
Retropharyngeal perforation	Perforation of the pyriform fossa

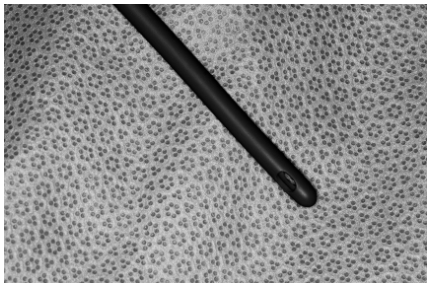

Figure 1. Urethral catheter round end.

Figure 2. Nasoendotracheal tube (Nasal ETT) lined up with funnel end of urethral catheter.

Figure 3. Nasal ETT securely seated into catheter.

Figure 4. Set-up once nasal ETT is attached catheter and ready for use.

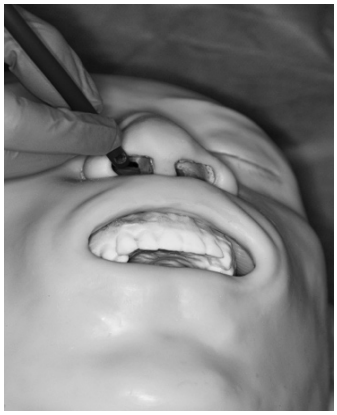

Figure 5. Introduction of the catheter into naris.

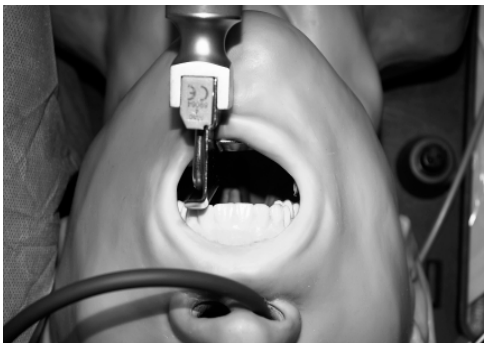

Figure 6. Catheter advancement thru naris to the posterior pharynx and visualized under laryngoscopy.

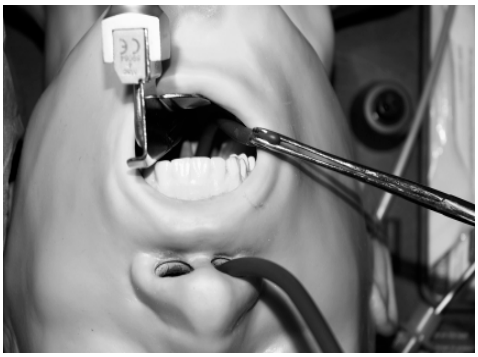

Figure 7. Use of Magill forceps to withdraw catheter thru mouth.

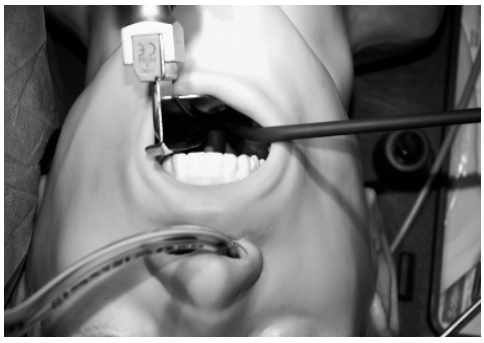

Figure 8. Removal of rounded end of catheter from ETT.

2. Literature Review

2.1. Review Methods

This literature review assesses the various alternative techniques for nasal intubation in patients undergoing oral surgery related to the incidence of bleeding and trauma to the airway. A literature search was conducted from electronic databases including PubMed, CINHAL, Medline, and OVID using the keywords: nasal intubation, nasotracheal intubation, red-rubber catheter, catheter guided, and epistaxis. The search combination of keywords included: nasal intubation and epistaxis, nasotracheal intubation and catheter guided, nasal intubation and catheter guided, red-rubber catheter and nasal intubation. The search was limited to articles in the English language published in peer-reviewed journals. Articles providing a historical reference were included in the search because of their ability to provide context and background for NTI. Furthermore, historical noteworthy articles offer a clear picture of the evolution and development of NTI. Conversely, more recent articles dating from 2002-2016 were utilized for providing the most current anesthesia practices and reviews for NTI. Titles, abstracts, and year of publication were primarily screened for application to this review. Studies pertaining to both children and adults were included. Articles pertaining to oral surgery using nasal intubation were included, however, articles not describing an alternative method for NTI were excluded. Articles in a foreign language were excluded. A total of 15 articles were utilized for this review. From those articles, 6 were randomized control trials graded at a level 2a, 1 was a non-randomized control study graded at level 2b, 3 were review articles graded at a level 3, 1 was a case series graded at a level 5, 2 were case reports graded at a level 6, and the last 2 were expert opinions graded at a level 7. One of the expert opinion articles was historically significant and therefore included in this review to acknowledge the first time the use of a red-rubber catheter technique was documented. Articles were graded using Polit and Beck's Evidence Based Practice Hierarchy, the Oxford Centre for Evidence Based Medicine model, and Central Michigan University's Evidence grading systems [4] [5] [6]. Ultimately, the articles were graded using Polit and Beck's Evidence Based Practice Hierarchy (**Table 2**) [5]. All articles included in this literature search were evaluated and

Table 2. Polit and Beck's Evidence Based Practice Heiracrhy [11].

Level of evidence		Type of study
I	a	Systematic Review of Randomized Clinical Trials (RCTs)
	b	Systematic Review of non-Randomized Clinical Trials
II	a	Individual RCT
	b	Non-randomized trial
III		Systematic Review of correlational/observational studies
IV		Correlational/observational study
V		Systematic Review of descriptive, qualitative, physiological studies
VI		Individual descriptive/qualitative/physiological study
VII		Expert opinion, expert committees

Table 3. Summary of Evidence.

Author Date	Evidence Type	Sample Size	Study Purpose	Evidence Level
Elwood, T. *et al.*, 2002	Randomized Control Trial (RCT)	98	Patients intubated with the red-rubber catheter method were associated with a significant reduction in obvious bleeding	IIa
Lim, C. W. *et al.*, 2014	RCT	60	To evaluate the use of a nasogastric tube as a guide to facilitate intubation compared with the conventional technique (blind insertion into the nasal cavity)	IIa
Watt, S. *et al.*, 2007	RCT	120	Comparison of the severity of epistaxis after nasotracheal intubation in children with tubes at room temperature, warm tubes, and tubes telescoped into catheters	IIa
Enk, D. *et al.*, 2002	RCT	60	Wendl tube (nasopharyn-geal airway) acting as a soft and flexible "pathfinder" for the rigid endotracheal tube was associated with decreased bleeding and tube contamination	IIa
El-Seify, Z.A. *et al.*, 2010	RCT	104	To investigate the efficacy and safety of topical vasoconstrictors and lubricants in reducing incidence of epistaxis during NTI intr- and postoperatively	IIa
Seo, K.S. *et al.*, 2007	RCT	200	To assess whether obturation of a conventional Murphey-tipped ETT with an inflated stethoscope reduces epistaxis and enhances navigability through nasal cavity compared to thermo-softening	IIa
O'Connell, J.E. *et al.*, 1996	Nonrandomized control study	100	To identify site and extent of anatomical injury post nasal intubation using traditional NTI methods	IIb
Abrons, O. *et al.*, 2016	Case Series	N/A	To report on a series of cases in which an endotracheal tube introducer (bougie) was utilized to facilitate NTI	V
Delgado, A.V. &Sanders, J.C., 2004	Case Report	N/A	To present a case in which a red-rubber catheter technique was utilized to reduce trauma during NTI in a patient with Factor IX deficiency	VI
Wong, A. *et al.*, 2011	Case Report	N/A	To describe a case in which a minimally invasive technique in which a red-rubber catheter is utilized to facilitate NTI and reduce trauma and bleeding to nasopharynx structures	VI
Hall, C.E & Shutt, L.E., 2003	Expert Opinion	N/A	To provide an overview of anatomy together with current indications and contraindications for NTI	VII
Prasanna, D. & Bhat, S., 2014	Expert Opinion	N/A	To provide overview of anatomy and methods for patient evaluation for NTI. Discuss preparation as well as insertion techniques, risks, and complications	VII
Chauhan, V. & Acharya, G., 2013	Expert Opinion	N/A	To provide basics of NTI and advances in the techniques for achieving NTI in addition to reviewing anatomy	VII

categorized using the criteria and guidelines outlined by Polit and Beck for the validity and quality of each publication and study (**Table 3**).

2.2. Summary of the Literature

In conducting a search of the current literature, it was revealed occurrence of epistaxis during NTI is remarkably high at 80% [2]. Randomized control studies conducted by Elwood, Stillions, Woo, Bradford, and Ramamoorthy along with Watt, Pickhardt, Lerman, Creighton, and Feldman studied the occurrence and severity of bleeding during NTI (**Table 4**). When using a red rubber catheter to guide a softened (warmed) nasal endotracheal tube (NETT), it was found to decrease the severity of nasopharyngeal bleeding *versus* using the softened NETT

Table 4. Outcomes of Randomized Control Studies Using Red Rubber Catheter [3] [13].

ELWOOD STUDY	Control	Red-Rubber Catheter
Number of patients	51	52
Time to intubate trachea, (s)	59	74
Incidence of bleeding	29.4%	9.6%
Both nares entered	18%	2%
WATT STUDY	Control	Red-Rubber Catheter
Number of patients	43	39
Time to intubate trachea, (s)	34	46
Incidence of bleeding	56%	5%
Incidence of no bleeding	21%	59%

(s) represents time it takes in seconds to intubate trachea.

alone [7]. However, it is prudent to mention even though the tube was telescoped into a catheter, clinically relevant epistaxis was significantly less regardless of the tube being at room temperature or warmed [3]. The central theme surrounding these studies was that the use of the red rubber catheter-guided technique significantly reduced bleeding during NTI, with the incidence of bleeding ranging from 5% - 9.6% [8].

It is important to include the added benefits of patient and surgeon satisfaction with respect to decreased airway trauma and surgical field maximization. Most commonly, nasotracheal intubation is utilized in the operating room for dental and intraoral procedures [9]. The presence of an orotracheal tube also contributes to the inability to provide adequate exposure for the surgeon [10]. Several authors concluded that NTI is an effective and safe technique that is underused in current practice [9] [10]. It can be easily argued that decreased trauma to the airway will result in decreased nasal pain perioperatively. The prevalence of inconsequential bruising to the mucosa overlying the inferior turbinate and adjacent septum has been reported as high as 54% [11]. In addition, other traumatic events such as accidental middle turbinectomy have also been reported [12]. These complications make visualization of the trachea difficult and can potentially introduce blood and debris into the lungs, thereby becoming an airway emergency [7] [8] [11]-[17]. Avoidance of nasopharyngeal trauma in the airway is favored by surgeons and anesthesiologists, as laryngospasm and aspiration have significant repercussions [14].

A cost analysis of the use of the red rubber catheter and other techniques mentioned in the literature to facilitate NTI were explored. The cost to manufacture a red rubber catheter is roughly $0.63 each depending on the size utilized, as assessed by one manufacturer, Covidien. The nasopharyngeal airways sometimes utilized to dilate the nostrils start at $3.00 each, also depending on the size as determined by one manufacturer, Rusch. Typically, providers will utilize two to three nasal trumpets to dilate the nares prior to intubation. Among

other techniques investigated for performing nasotracheal intubation involved the use of a nasogastric tube guided technique [16]. The manufacturer, Covidien, supplies nasogastric tubes to hospitals at roughly $2.95 each. As illustrated above, utilizing the red rubber catheter technique over other methods for NTI is a cost-efficient way to improve patient care.

In two studies, authors describe a decreased incidence of pain reported by adult patients postoperatively following nasal intubation using a pathfinder technique for NTI [17] [18]. Future recommendations would be to conduct postoperative assessments in the pediatric population to correlate findings. A case report by Delgado and Sanders determined a pediatric patient with known factor IX deficiency was successfully nasally intubated with the red rubber catheter technique. No evidence of bleeding was reported, suggesting that the technique may be safe to use even in patients with known coagulopathy provided the method is carried out correctly [15].

Transfer of bacteria from the nasal cavity into the lungs via the trachea can occur during NTI [1]. It has been observed that dental procedures requiring general anesthesia and NTI pose a higher risk of bacteremia, especially in patients with prosthetic heart valves [1] [10]. Several studies mentioned the advantage of using a catheter-guided method and the decreased incidence of endotracheal tube contamination [1] [2] [15] [17]. Protecting the tip of the tube with a soft, flexible catheter prevents the contamination of mucous or tissue in the endotracheal tube from being transmitted into the trachea or bronchus. Enk, Palmes, Van Aken, and Westphal conducted a blinded randomized control trial using a pathfinder technique and found tube contamination with blood and mucous was remarkably decreased and significant by $P < 0.001$ [17]. Abrons, Vansickle, and Ouanes presented three case reports in which an endotracheal tube introducer or bougie was used to facilitate successful and atraumaticnasal intubation using a Seldinger technique [18]. The authors discussed how the use of a nasal bougie can guide tubes through narrow nasal passages and small pharyngeal spaces without transoral manipulation [19]. The use of an esophageal stethoscope for NTI also proved to be effective as well in reducing epistaxis and reducing trauma in a randomized control study from Seoul University School of Dentistry [18].

Areas of weakness or inconsistency found in the literature search were the randomized control trials (RCT) did not utilize consistent techniques for nasal intubation and instead performed NTI with a variety of alternative methods. Only two RCTs were consistent in using the red rubber catheter technique, suggesting that more trials using this precise method need to be conducted. It is important to also consider the time taken to intubate the trachea with a red rubber catheter was increased by 12 - 15 seconds compared to traditional methods utilizing no catheter assistance. The other techniques mentioned were using an esophageal stethoscope, a nasopharyngeal airway, and a nasogastric tube to guide the endotracheal tube through the nasal passage. The case reports pre-

sented did have significance in proving the efficacy of the catheter method; however, not all the reports were centered on children. This method could also be considered useful in the adult population for NTI.

Future recommendations to promote an increased use of the red rubber catheter guided technique are to be addressed and investigated. As it is, there is currently no gold standard for NTI. Various techniques are demonstrated in the current literature including but not limited to the use of a nasogastric tube, a nasopharyngeal airway, an esophageal stethoscope, a red rubber catheter, softened nasal endotracheal tube, or nothing at all [1] [2] [3] [7] [8] [13] [14] [15] [16] [17]. The red rubber catheter technique is not complicated to perform with proper teaching and demonstration. The need to develop a practice recommendation for NTI seems imperative because providing consistently safe anesthesia care begins with evidence-based practice and current literature. Once a standard has been developed, it can be integrated into the educational curriculum. Developing a format to successfully train existing anesthesia providers unfamiliar with this technique will also be required and needs further investigation. Additionally, providing easy access to this catheter by having it readily available may improve implementation among providers. Supplying prepackaged nasal endotracheal tubes with an appropriately sized catheter based on tube diameter would facilitate implementation. Easy access, along with significantly less time spent gathering supplies and eliminating estimation of catheter size to use will ease clinical use. Lastly, utilizing a latex-free catheter would be advantageous because it will permit the utilization of the technique on a larger number of patients. Newer nasal endotracheal tubes have been developed and made from siliconized PVC material making them more flexible and softer and thus more favorable; however, it is still important to consider possible tube contamination and mucosal tear when inserting the tube through the nasopharynx.

3. Discussion

The information gathered from the existing literature suggests the use of a catheter-guided technique for nasotracheal intubations has contributed to decreased trauma to the nasopharynx, decreased bleeding, decreased perioperative pain, and prevention of tube contamination. Special considerations should be taken depending on patient population and appropriateness for utilizing this method (*i.e.*, LeFort fractures, coagulopathies, and latex allergy individuals). The overall strengths presented in the literature are the safety efficacy and decreased morbidity rate associated with implementing this method for nasal intubations. It is important to consider as a result of decreased incidences of bleeding and trauma, patients will experience fewer postoperative complications such as nausea, vomiting and pain [7] [8] [16] [17].

Undoubtedly, most anesthesia providers will agree that "blood in the airway can make an easy intubation difficult, obscuring the view of the larynx and increasing the potential for aspiration of blood" [7] (p53). Existing literature sup-

ports the notion using a catheter-guided technique versus nothing at all will decrease potential complications associated with nasal intubations. The challenge will be instituting this technique as a practice guideline for nasal intubations. Future research may establish teaching guidelines to promote and sustain implementation in clinical practice, as well as incorporating this technique in educational curriculums. Hopefully, this knowledge will help anesthesia providers in delivering enhanced patient care.

4. Conclusion

The studies reviewed in this article provide evidence that use of a catheter-guided technique for nasal intubations is associated with a significantly lower rate of epistaxis and airway trauma, eliminate endotracheal tube contamination, and show a decreased rate of morbidity and mortality in patients during the perioperative period, as compared to conventional methods.

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