SUCTION CATHETER GUIDANCE OF THE ENDOTRACHEAL TUBE TO FACILITATE NASAL INTUBATION: A DOUBLE BLIND, RANDOMISED CLINICAL TRIAL

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Abstract

Background: The passage of the endotracheal tube (ETT) through the nose during nasotracheal intubation is sometimes difficult and may cause trauma and epistaxis. We evaluated whether the use of a PVC suction catheter as a guide for the ETT through the nasal passages during nasotracheal intubation can improve its navigability and reduce nasal trauma and epistaxis.

Methods: The study was performed on 156 patients (aged 3-43 yr) requiring nasotracheal intubation for tonsillectomy with or without adenoidectomy. Patients were first categorized into two equal-sized strata based on age (children; <18 years or adults; 18 years or more) (n=78 each). Within each stratum, patients were randomly allocated into two equal-sized groups (n=39 each); Guided group (GG group; nasal intubations were guided by PVC suction catheters) and Control group (CG; unguided nasal intubations).

Results: ETT navigation was significantly easier and epistaxis was significantly less in the guided groups than the control. The ETT failed to passed through the first chosen nostril and the other nostril was used for intubation significantly less often in the guided groups. The ETT failed to pass through both nostrils in 2 of the patients of the control group but could be passed using the guide. Post-extubation nasal endoscopy revealed more clots and lacerations in the nasal mucosa of the control group patients.

Conclusion: Guiding the ETT over a PVC suction catheter to the nasopharynex during nasotracheal intubation is a simple and effective technique that facilitates ETT navigation through the nasal passages and reduces epistaxis and nasal mucosal damage.

Introduction

The nasal route for tracheal intubation has long been used effectively to offer an undisturbed surgical field during oral, pharyngeal, laryngeal and maxillofacial surgeries. Nasal intubation can usually be performed easily without complications[1]. Significant trauma can however occur during the introduction of the tube through the nasal passages. Epistaxis is a frequent occurrence that can be severe enough to disturb the work of the anesthesiologist as well as the surgeon[2-4]. Failure of endotracheal tube passage through the nose can modify anesthetic and surgical plans. Submucous tracking to the pharynx[5], middle turbinate dislocation[6], and accidental turbinectomy

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or adenoidectomy[7,8] have been reported during nasal intubation.

Intranasal pathology that can impede the passage of the tube may exist but difficult to be predicted. Simple pre-induction tests to foretell the patency of nasal passages and to detect the more patent nostril are frequently used such as estimation of the rate of airflow through each nostril during expiration. These tests however, have high diagnostic failure rates[9], and they are not suitable for children. Simple anterior rhinoscopy with the aid of a nasal speculum may be used to foresee difficulties during nasal intubation. This however, can also be misleading and it cannot detect abnormalities that can exist in the posterior nasal cavity. O'Connell et al[1], using preoperative anterior rhinoscopy, failed to identify those patients who subsequently proved difficult or impossible to intubate nasally and incorrectly predicted difficulty in 11 out of 100 patients included in their study.

Preliminary fiberoptic nasal endoscopy has been suggested to have a role in the anesthetic assessment and management before nasal intubation. It can provide more accurate diagnosis of nasal abnormalities, even though its results have been advised[10] not to be absolute or immutable regarding nasal intubation. Ahmed-Nusrath et al.[10] used fiberoptic nasal endoscpy and selected one nostril for intubation as being more patent than the other in 60% of asymptomatic patients who breathe equally through both nostrils. Despite that, 54% of their tubes encountered moderate resistance causing more epistaxis. However, this is yet a new aspect of fiberoptic nasal endoscopy for most anesthesiologists and requires practice, training and the availability of expensive equipment. Fiberoptic nasal endoscopy before nasal intubation is therefore not commonly used[11]. Accordingly, the anesthesiologist is always blind to the anatomical features of the nasal cavity and relies on his experience and sense of applying a threshold pressure to overcome an unexpected resistance without trauma before manipulating the ETT or turning to the other nostril. Possibly however, miscalculation can occur in the most skillful hands.

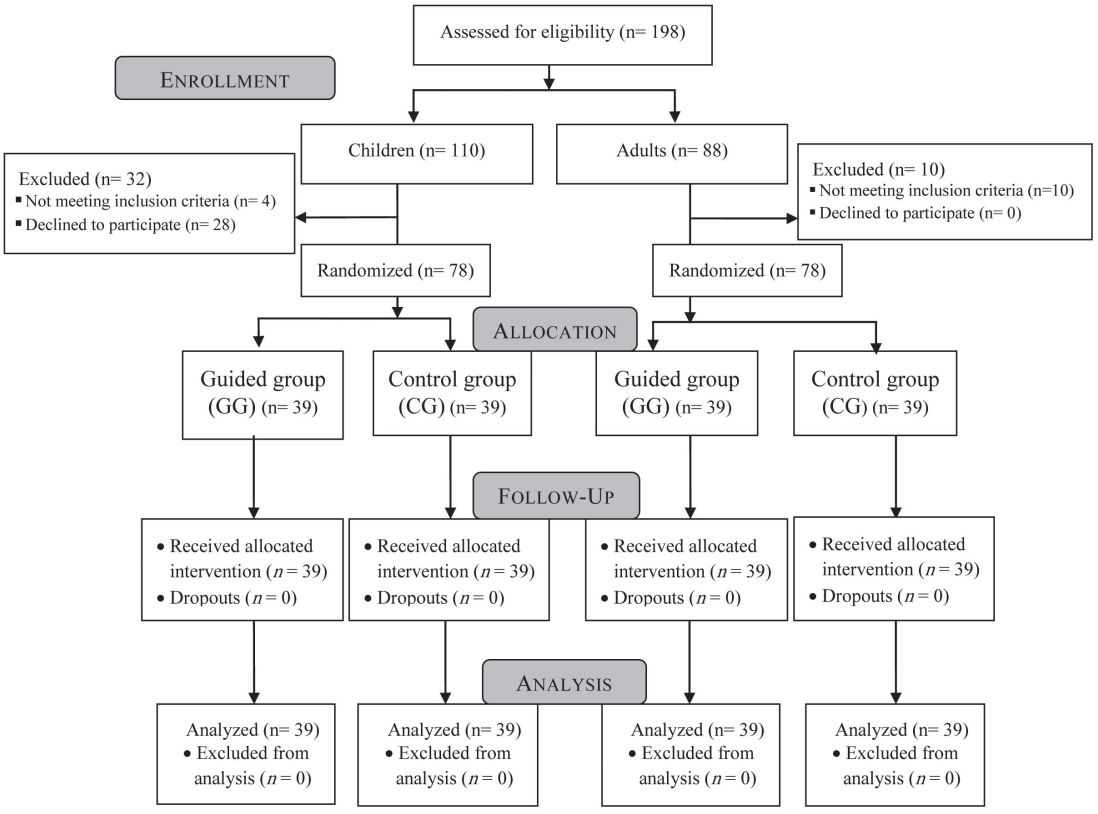
Several suggestions have been made to facilitate the passage of the ETT and to reduce trauma during nasal intubation[12-18]. However, they were either time-consuming, precluding routine utilization or required special equipment that might not be readily available in many operating theaters. In this study, we tested a simple technique to facilitate nasal intubation utilizing a PVC suction catheter that can be easily accessible in almost all operating rooms.

Methods

This manuscript adheres to the applicable Equator guidelines. The protocol of this study was registered before patient enrollment at the IRB and approved by the Ethics Committee of Faculty of Medicine, University of Alexandria (registration number 1035). A written informed consent was obtained from each patient (or from the parents in case of children) who agreed to participate in our study. The study was conducted on 156 patients, aged from 3 to 43 years, requiring nasotracheal intubation for tonsillectomy with or without adenoidectomy. Half of the patients were adults (aged from18 to 43 years) and the rest were children (<18 years) (Fig. 1). Patients with abnormal coagulation status or taking any medication that may affect hemostasis and those with a history of nasopharyngeal surgery or recurrent epistaxis were excluded from the study. Eligible patients were randomised according to a stratified block randomisation scheme. Patients were first categorized into two strata based on age (adults or children). Randomisation proceeded within strata according to a permuted block scheme with a block size varying randomly between 4 or 6 according to the outcome of a computer generated random number. Patients in each stratum were thus categorized randomly into two equal groups: guided group (GG) and control group (CG) (39 patients each). The computer generated randomisation list and treatment assignments were prepared by an investigator with no clinical involvement in the trial. In guided group (GG) patients, nasal intubations were guided by PVC suction catheters. In control group (CG) patients, nasal intubations were performed directly without a guide. Standard Magill tipped endotracheal tubes were used in the study (Flexicare Medical Ltd, Mountain Ash, Mid Glamorgan, UK).

Anesthesia was standardized for all patients. After the application of routine monitoring and preoxygenation, anesthesia was induced with

Fig. 1
Flow diagram of patients in the stua



fentanyl 1 μg.kg^{-1} and propofol 2-3 mg.kg^{-1} followed by Rocuronium 0.6 mg.kg^{-1} to facilitate tracheal intubation. The patient was mask ventilated with 3% sevoflurane in 100% oxygen until muscular relaxation was complete. The wider looking nostril was chosen for starting intubation. If both nostrils appeared similar, the right nostril was used for starting intubation. All surgeries were performed by the same ENT surgeon and all intubations were performed by the same consultant anesthesiologist. The proper sized ETTs were selected for children according to the formulae: Internal diameter (ID) (mm) = (age/4) + 3.5 for un-cuffed tubes and ID (mm) = (age/4) + 3 for cuffed tubes[19,20]. For adults, ETTs of 7 and 6.5 mm ID were used for male and female patients respectively. Cuffed ETTs were used for all patients above the age of 8 years and un-cuffed tubes for those under this age[21]. No vasoconstrictor nasal drops were used and the tubes were well lubricated with water soluble jelly immediately before intubation.

In the control group patients (CG), the ETT was advanced gently through the selected nostril against the floor of the nose towards the nasopharynx. Gentle rotation and tilting of the tube was done during its advancement if resistance was faced. If the tube failed to enter the pharynx the other nostril was used with gentle rotation or tilting of the tube as needed. If passage of the tube through the other nostril also failed the catheter guided technique was tried before the decision of shifting to oral intubation. Failure of the tube passage through each nostril was recorded. After the passage of the tube tip to the pharynx, tracheal intubation was completed under direct laryngoscopy using Magill forceps.

In guided group patients (GG), a well lubricated PVC suction catheter (Ghatwary Medical Supply [GMS], Alexandria, Egypt) was first inserted through the ETT so that about 10 cm of the catheter was protruding from the distal end of the tube (Fig. 2). Ten-French catheters were selected for ETTs 5.0 mm ID and smaller, and 12-French catheters were used for ETTs 5.5 mm ID and larger. The tip of the catheter was then inserted gently through the selected nostril until it passed to the pharynx. If a resistance was felt to the passage of the catheter, the other nostril was tried. The nostril with less resistance to the catheter passage

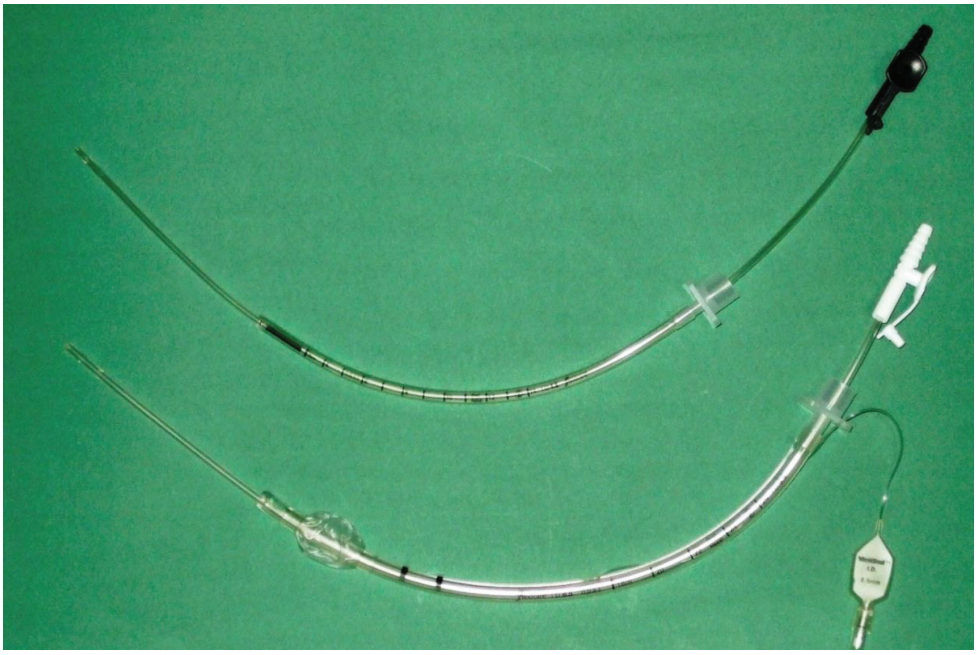


Fig. 2
A well lubricated PVC suction catheter inserted through the ETT so that about 10 cm of the catheter was protruding from the distal end of the ETT

was chosen for the completion of the procedure. The ETT was then advanced over the catheter through the nasal passages while holding the catheter proximal to the tube to prevent its advancement with the tube. Fixation of the catheter while advancing the ETT is an important part of the technique to prevent its forward movement with the ETT and the possibility of its kink distal to the tube blocking its advancement. After the passage of the tube tip to the pharynx, the suction catheter was withdrawn from the ETT and tracheal intubation was completed under direct laryngoscopy using Magill forceps.

The anesthesiologist who performed the intubations recorded the success of intubation attempts through each nostril and evaluated the ease of navigation of the ETT through the nasal passages, defined as easy, medium, difficult and impossible[13]. The E.N.T. surgeon, who did not attend airway instrumentation and was unaware to which group the patient belonged, estimated the extent of epistaxis after placing the Boyle-Davis gag for surgery 5 min after nasal intubation. Epistaxis was estimated on a scale of "no epistaxis" to "severe epistaxis". "No epistaxis" represented no blood in the pharynx, "mild epistaxis" indicated blood on the nasotracheal tube only, "moderate epistaxis" indicated some blood pooling in the pharynx, and "severe epistaxis" represented a lot of blood sufficient to impede intubation and surgical view[11]. Nasal passage time was calculated in the CG starting when the tip of the ETT just entered the anterior nares until the tip of the ETT just passed the posterior nares and entered the pharynx. In GG, nasal passage time was calculated starting when the tip of the guiding suction catheter just entered the anterior nares until the tip of the ETT passed the posterior nares and entered the pharynx and the guiding catheter was completely removed from the ETT.

In the post anesthesia care unit, a further blinded otolaryngologist examined the nasal mucosa with a flexible fiberscope (Karl Storz). Nasal trauma was classified as none/bruises or clots/lacerations of the nasal mucosa.

Statistical Analysis

Sample size estimation was performed to detect a 30% difference between the groups with respect to epistaxis. We calculated that 39 adults and similar number of children should be included in each group for a subgroup analysis with an alpha error of 0.05 and a power of 0.8 (On the basis of 50% incidence of epistaxis). Data are presented as median (25^{th} percentile, 75^{th} percentile) or frequencies and percentages as appropriate after being assigned as nonparametric based on the Kolmogorov and Smirnov test. The SPSS software (version 15.0; SPSS Inc,

Table 1
Demographic data and nasal intubation characteristics

		Guided G (GG)	Unguided G (CG)	Statistics P=
Age	Child	6(4,10)	5(4,6)	0.135
	Adult	25(21,30)	24(19,28)	0.110
	Total	16 (6, 25)	13.5(5,24)	0.276
Sex (M/F)	Child	21/18	22/17	1.0
	Adult	20/19	24/15	0.49
	Total	41/37	46/32	0.52
Operation (T/TA)	Child	6/33	5/34	0.745
	Adult	39/0	38/1	0.237
	Total	45/33	43/35	0.872
Nasal intubation time (sec.)	Child	7(6, 12)	6(4, 14)	0.230
	Adult	9(6,12)	8(5,11)	0.115
	Total	8 (6, 12)	7 (4, 12.25)	0.077
Nostrils entered by ETT one/two	Child	38/1	30/9	0.014
	Adult	39/0	31/8	0.005
	Total	77/1	61/17	<0.0001
Epistaxis(No/mild/moderate/severe)	Child	23/11/1/4	11/8/4/16	0.002
	Adult	25/9/5/0	6/11/9/13	<0.0001
	Total	48/20/6/4	17/19/13/29	<0.0001
Navigability 1/2/3/4	Child	34/4/1/0	21/6/9/3	0.002
	Adult	35/4/0/0	22/9/8/0	<0.0001
	Total	69/8/1/0	43/15/17/3	<0.0001
Nasal mucosal damage (None or Bruse/ Crust or Tearing)	Child	32/7	21/18	0.008
	Adult	34/5	19/20	<0.0001
	Total	66/12	40/38	<0.0001

Chicago, IL) was used for statistical analysis. Age and duration of tube passage through the nasal cavity were compared using the Mann-Whitney U test. Sex, type of operation, severity of epistaxis, the ease of tube navigation through the nasal passages and the extent of post-operative nasal mucosal injury were analyzed by Pearson Chi-Square test or the Likelihood Ratio when appropriate. Values of $P<0.05$ were considered statistically significant.

Results

Out of 198 patients assessed for eligibility, 156 patients fulfilled inclusion criteria and signed consent form. Half of the participated patients were children and the rest were adults and they were investigated to the end of the study protocol with no dropouts (Fig. 1).

No significant differences were found between the two tested groups regarding age, sex and the type of surgical operation performed (Table 1). The use of a suction catheter as a guide to facilitate nasal intubation was successful and easy in all the tested patients without a single failure or complication.

Epistaxis following nasal intubation was significantly less in the guided group than in the control ($P<0.001$) (Table 1; Fig. 3). Also, navigation through the nasal passages was smoother with less impingements in the guided group than in the control ($P< 0.001$) (Table 1; Fig. 4). In the post-anesthesia care unit, fiberoptic nasal endoscopy revealed more clots and nasal mucosal lacerations in the control group than in the guided group ($P<0.001$) (Table 1; Fig. 5). Similar results were obtained when we compared the tested children (< 18 years) or adult patients (18 years and over) of each group with the patients of the same age category in the other group ($P=0.002$ and 0.04

Fig. 3
Severity of Epistaxis after nasal intubation

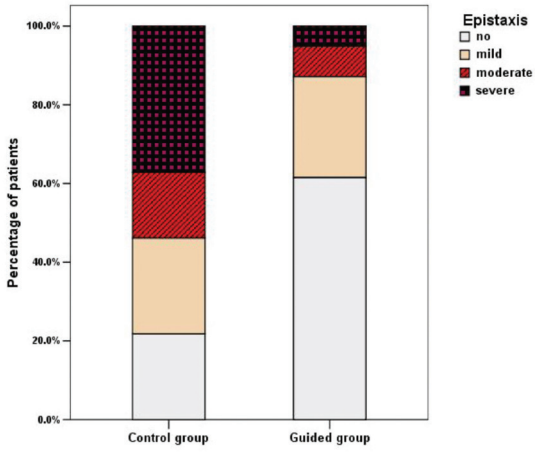


Fig. 4
Ease of ETT navigation through the nasal passages during nasotracheal intubation

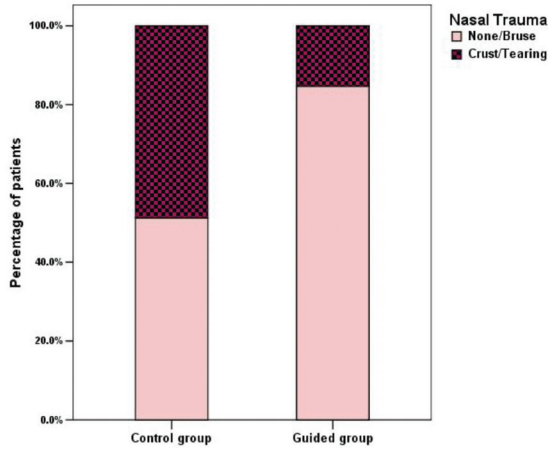
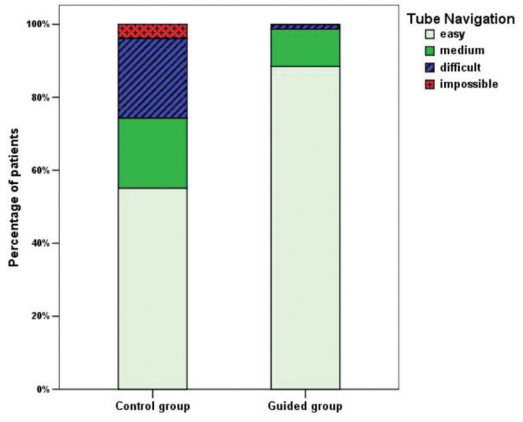


Fig. 5
Nasal mucosal trauma after nasal intubation as revealed by fiberoptic nasal endoscopy in the post-anesthesia care unit



respectively) (Table 1).

There was no significant difference between the groups as regards the duration of nasal intubation to the nasopharynx (P=0.077) (Table 1). However, the ETT failed to pass through the first attempted nostril and the other nostril was used for intubation significantly more often in the control than in the guided group (P<0.001) (Table 1). Also, the ETT failed to pass through the nose to the nasopharynx in two of the patients of the control group after several tilting and manipulation through both nostrils but could be passed with mild to moderate resistance when the guided technique was used. Submucosal passage of the endotracheal tube was noticed in two of the patients of the control group. After moderate difficulty of tube navigation through the nose, the tube was seen under the mucous membrane of the pharynx during laryngoscopy. The tube was withdrawn and reinserted successfully through the other nostril with no later sequlae. This incident was not seen among the guided groups' patients.

Discussion

This study supports the benefit of using a guide to facilitate nasal intubation. Navigation of the guided tracheal tube in the nasal passages was significantly smoother with less impingement than the control while epistaxis was significantly less. Assessment of the nasal mucosa after extubation indicated less trauma to the nasal passages. Similar results were obtained by all the investigators who used different techniques to facilitate the passage of the ETTs through the nose[12-18]. Also, the use of the guided technique can be a solution when ETT fails to pass through the nasal passages by the traditional technique as demonstrated in two of the patients of our control group.

Smith and Reid[22], using fiberoptic nasal endoscopy, found that 68% of asymptomatic oral surgery patients presenting for nasal intubation had intranasal abnormalities (58% unilateral and 10% bilateral), and in 37%, the deformity was severe which might render the patient vulnerable to significant nasal trauma. Their patients were selected as having no history of nasal obstruction or trauma, and reported being able to breathe easily and equally through both nostrils, and this was confirmed by palpating the air

flow through each nostril during expiration. With this high incidence of the unpredictable hazard of difficulty and trauma during nasal intubation, the routine use of a method to facilitate the tube passage through the nose should be beneficial in reducing associated morbidity. To promote routine use, the method should be simple, hazardless, easy to perform, readily available without sophisticated preparation and not expensive. Most of the suggested approaches are either sophisticated, or require special equipment that may not be readily available for routine use in most operating theaters. The anesthesiologist can however, choose the most comfortable technique that suits his working conditions and facilities.

Thermo-softening of the endotracheal tubes just before nasal intubation was found to be effective in reducing the incidence of epistaxis and nasal trauma[12]. However, the technique can be time consuming if used routinely in busy operating theaters and may jeopardize sterilization of the tube. Also, the possibility of overheating of the tube that may have serious consequences cannot be under emphasized if the technique is utilized routinely in different operating theaters[23-26].

MacKinnon and Harrison[13] used a red rubber catheter applied over the distal end of the ETT trailing it through the nasal passages to the oropharynx, and Elwood et al.[27] and Watt S et al.[28] evaluated the efficacy of this technique in children. Enk D, et al.[14] modified the technique and used a nasopharyngeal airway (Wendl tube) as a pathfinder after removing its adjustable flange and inserting the tip of the endotracheal tube into its trailing end. The Wendl tube or the red rubber catheter was removed with a Magill forceps after the guided endotracheal tube was positioned in the oropharynx. The technique was found effective in reducing epistaxis during nasal intubation and was used effectively to solve specific intubation problems in several case reports[2,28]. A drawback of this technique is the possibility of disconnection of the ETT tip from the pathfinder if it is drawn back during manipulation. Also, there is a potential risk of losing the pathfinder that may enter the esophagus or may pass through the glottis if the ETT is advanced blindly[14]. The pathfinder should therefore be visually observed in the oropharynx during the passage of the ETT through the nose which can increase difficulty. The tip of the red rubber catheter or the Wendl tube may be brought out of the patient's mouth with a Magill forceps before completing nasopharyngeal passage in order to minimize this risk[2,14,29]. In a likewise manner, a cut middle finger of a large glove was fitted over the bevel end of the ETT to reduce nasal trauma[30,31]. The glove finger was removed with Magill forceps under direct vision after the tube passed the nasal passages. Alongside the potential risk of foreign body deglutition or aspiration, Barras et al.[32] reported disappearance of the finger cot that was discovered 5 months later in an inflammatory mass situated between the trachea and the sternocleidomastoid muscle.

Similar to our utilized technique, Morimoto Y, et al.[15] used a curved tipped angled portex suction catheter that was specially designed for suctioning each bronchus separately, and Cossham PS[16], used a gum-elastic bougie with angulated tip to railroad the tracheal tube to its correct path. Seo KS et al.[17] obturated the ETT tip with an inflated esophageal stethoscope, and Watanabe S et al.[18] used an Airguide tube system in which they used a non-beveled (even cut) tracheal tube with a Murphy eye, and a soft stylet with a balloon that was inflated at and to about 0.5-1 cm beyond the distal end of the tube. Obviously, most of these suggested techniques utilize equipment that may not be readily ready for the anesthesiologist for routine use in many operating rooms.

The PVC suction catheter is soft, flexible, atraumatic, and not expensive. It is always readily available in almost all operating theaters. Its flexibility enables its smooth slipping to find its way in the nasal passages without trauma. The guided ETT can then be directed to the correct path directly over the catheter without impingements, reducing trauma to nasal tissues and minimizing the possibility of submucosal insertion. In addition, the introduction of the fine atraumatic catheter through both nostrils may provide a clinical provisional expectation of the more patent nostril that can be easier for intubation. Furthermore, the presence of the catheter inside the lumen of the ETT during its passage through the nose can decrease the possibility of its contamination with blood, mucous or dislodged tissues from the turbinates or the adenoids and their subsequent introduction into the airways.

It has been argued[13] however, that retraction of intraluminal guiding devices may cause contamination of the inner lumen of the ETT with mucous or blood that pools in the pharynx. A possible solution that can negate this concern is an application of a rapid suction through the guiding catheter just before its withdrawal from the ETT[33].

The ideal endeavored passage of the ETT through the nose during nasotracheal intubation is along the nasal floor, underneath the inferior turbinate (the lower pathway). This might be safer than passing the tube through "the upper pathway"; above the inferior turbinate and below the middle turbinate as the later is a vascular structure, attached to the ceribriform plate of the ethmoid complex by a thin lamella, loosely anchored to the ethmoidal air cells and can be injured or partially avulsed causing severe epistaxis. Ahmed-Nusrath et al.[10], using fiberoptic nasal endoscopy after traditional nasal intubation found that only 16.7% of the preformed tubes were passed through the lower pathway while the rest took the upper pathway in spite of specific attempts to avoid this. They also found that significantly more reinforced tubes (56.7%) took the lower pathway and explained their better performance by having the flexibility required to enter narrow pathways. In our study, we did not do fiberoptic nasoscopy to confirm the nasal pathway taken by our ETTs. However, a fine flexible catheter can presumably be passed more easily through the endeavored pathway to guide the ETT to find its way through this passage. Once the ETT follows the favored passage, its migration to the other pathway is most likely prevented by the medial border of the inferior turbinate, which approximates to the nasal septum.

There are some limitations to this study. Consistent with our routine practice, we did not use a topical vasoconstrictor. The routine use of a topical vasoconstrictor however, is disfavored by some authors[17,29,34] concerning its unpredictable absorption and delivered drug dose and the hazard of associated circulatory side effects.

In conclusion, the use of a PVC suction catheter as a guide for the ETT through the nasal passages, during nasotracheal intubation, facilitates ETT navigation and reduces epistaxis and nasal mucosal damage. The technique is worthy of being encouraged to be used routinely during nasotracheal intubation in view of its advantages, simplicity, cheapness and availability.

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