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Nasopharyngeal airway effectiveness in reducing epistaxis prior to nasal intubation

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ABSTRACT

Nasotracheal intubation inherently carries the risk of epistaxis, which can impact patient safety, airway, and the overall surgical procedure. Epistaxis may occur during the intubation, obstructing the anesthetist's view of the vocal cords and complicating the procedure. The aim of this study is evaluated the efficacy of prophylactic nasopharyngeal airway (NPA) placement in mitigating the incidence and severity of epistaxis associated with nasotracheal intubation. A randomized controlled trial was designed to include 60 patients undergoing elective oral and maxillofacial surgery requiring nasotracheal intubation. Participants were randomly included in the intervention group (n=30), receiving prophylactic NPA placement, or the control group (n=30) without NPA. In the intervention group, a lubricated nasopharyngeal airway was inserted and maintained for two minutes before nasotracheal intubation. The NPA was removed, and standard nasal intubation with an endotracheal tube was performed. The primary outcome measure was the incidence and severity of epistaxis, assessed at two time points: immediately post-intubation and immediately post-extubation. The incidence of epistaxis after intubation was lower in the NPA group (13.3%)

compared to the control group (36.6%, p = 0.037). The overall incidence and severity of epistaxis were also lower in the intervention group. Patients in the control group were over 4 times more likely to experience a higher grade of epistaxis compared to those who received nasopharyngeal tubes. In conclusion; pre-lubricated nasopharyngeal airway placement before nasotracheal intubation reduces the incidence and severity of epistaxis. This simple intervention can improve patient safety and optimize airway management during procedures requiring nasotracheal intubation.

Keywords: epistaxis, nasotracheal intubation, nasopharyngeal airway

INTRODUCTION

The technique for nasal intubation was initially outlined by Kuhn in 1902. Additional innovators of nasal intubation techniques are Macewen, Rosenberg, Meltzer, Auer, and Elsberg. Rowbotham and Magill invented and used the technique of "blind" nasal intubation during World War I, for which they coined the name. This approach was subsequently popularized by Magill and has been widely utilized thereafter [1].

Nasotracheal intubation is a method of establishing an airway by inserting an endotracheal tube through the nasal cavity and nasopharynx into the trachea, commonly utilized in oral and maxillofacial surgeries owing to the positioning of the operative site within the oral cavity and the requirement for the surgeon to maintain direct access to the surgical field. This method may be beneficial relative to orotracheal intubation, as it reduces the likelihood of complications linked to orotracheal intubation, including unintentional separation of the endotracheal tube from the ventilator or damage and rupture of the tube, which could jeopardize patient safety and the overall efficacy of the surgical procedure [2].

Nasotracheal intubation (NTI) is commonly performed in a variety of clinical scenarios, including oral and maxillofacial surgery, where it allows the surgeon unobstructed access to the operative site within the oral cavity; certain trauma cases, such as facial fractures, where orotracheal intubation would be contraindicated; Preferring of the NTI as approach to secure the airway in cases of difficult intubation or limited neck mobility; and patients with certain upper airway pathologies, such as tumors or anatomical abnormalities, that may impede or obstruct orotracheal intubation.

In situations where there is severe coagulopathy, nasal trauma/fractures, and patients with a history of difficult nasal intubation, the NTI is generally not recommended. Additionally, NTI should be avoided in patients with nasal polyps, significant nasal septal deviations, or other anatomical abnormalities that could impede the passage of the endotracheal tube through the nasal cavity.

Complications of nasotracheal intubation include epistaxis (the most common complication), resulting from abrasion of the nasal mucosa when the tube is passed posteriorly, damage to nasal cavity (avulsion of nasal polyps, fracture of the turbinates, septal abscesses), aspiration, vagal stimulation, laryngospasm, vocal cord damage, bacteremia from the introduction of nasal flora to the trachea, and pneumothorax. These complications can arise due to the complex and delicate anatomy of the nasal cavity, which includes narrow, curved passages and a highly vascularized nasal mucosa affected by introducing intubation instruments [3]. The incidence of epistaxis, or nasal bleeding, during nasotracheal intubation is relatively high, ranging from as low as 8% up to as high as 80% across various studies[3, 4]. This complication can be problematic, as it may obscure the surgeon's field and compromise patient safety.

Epistaxis, or nasal bleeding, is the most common complication associated with nasotracheal intubation and can cause blood to pool in the pharynx. This pooled blood can impede visualization

of the airway and make ventilation challenging both during the intubation procedure and in the postoperative period. Obscure the visualization of the vocal cord and larynx during laryngoscopy, thereby complicating the intubation process and increasing the risk of trauma or failed intubation attempts [2, 5, 6]. Severe epistaxis, or profuse nasal bleeding, during nasotracheal intubation, can have serious and life-threatening consequences [7]. The significant blood loss associated with severe epistaxis can lead to hemodynamic instability, where the patient's blood pressure and circulatory function are severely compromised. This hemodynamic instability can further complicate patient management, as the healthcare team must urgently address the underlying bleeding while also maintaining the patient's overall physiological stability, which is critical for their survival and recovery [8]. The complications of epistaxis can include difficult laryngoscopy and intubation, challenging mask ventilation and airway management, hemodynamic instability and hypotension, obstructed visualization of the surgical site, surgery postponed or delayed, aspiration pneumonia, and acute respiratory distress syndrome (ARDS). These respiratory complications can further jeopardize the patient's well-being, stability, and long-term prognosis, highlighting the critical importance of reducing the risk of epistaxis during nasotracheal intubation [2, 7].

The nasal cavity has significant anatomical connections to the paranasal sinuses, brain, throat, esophagus, and trachea via the nasopharynx. The nose is partitioned by a primarily cartilaginous nasal septum into two nostrils [9]. Each nostril contains two airflow pathways, a lower channel along the nasal floor beneath the inferior turbinate and an upper path above the inferior turbinate and below the middle turbinate. The middle turbinate is richly vascularized and linked to the cribriform plate, hence the insertion of a nasopharyngeal airway or the execution of nasotracheal intubation in this area poses a danger of vascular injury. Therefore, the lower nasal pathway is the

preferred route for airway device insertion [10]. The anatomical path starts at the nasopharynx, which is connected to the oropharynx and extends inferiorly to the hypopharynx. The hypopharynx is located posterior to the larynx and superior to the openings of the trachea and esophagus [11]. When observed in a superior-to-inferior orientation, the key laryngeal structures visible include the vallecula, epiglottis, and vocal cords, which provide access to the trachea. The nasal cavity contains three sets of turbinates, superior, middle, and inferior that are situated along the lateral walls of the nasal cavity. These turbinates can obstruct the smooth passage of the endotracheal tube, leading to potential abrasions and bleeding [12]. Additionally, the curvature of the nasal passages, particularly the nasal septum and floor, can make it challenging to advance the tube without causing inadvertent contact with the sensitive nasal tissues. The highly vascular nature of the nasal mucosa further exacerbates the risk of epistaxis, as even minor trauma can result in significant bleeding [4].

Reducing the risk of epistaxis, or nasal bleeding, is critical for the safety and success of nasotracheal intubation and the overall surgical procedure. Although the potential risks and challenges of nasotracheal intubation, the use of a nasopharyngeal airway has been identified as a promising approach to effectively lower the incidence of epistaxis during this procedure [10, 12].

A nasopharyngeal airway (NPA) is a hollow, soft, and flexible tube that can be inserted through the nasal cavity and into the nasopharynx [13]. This device is designed to maintain a patent airway by providing an unobstructed passage for air to flow through the nose and into the lungs. The NPA is typically made of a pliable material, such as rubber or silicone, which allows it to conform to the natural curves and contours of the nasal anatomy without causing significant irritation or trauma to the delicate nasal tissues [14]. When properly inserted, the NPA extends from the nostril, through the nasal cavity, and into the nasopharynx. By occupying this space, the NPA helps keep

the airway open and facilitates unimpeded breathing, which is a critical function in various medical situations where the upper airway may be compromised [11, 15]. Selecting the appropriate size of the NPA is crucial to ensure its proper fit and function. The size of the NPA should be chosen based on the patient's age, and nasal anatomy. Typically, the diameter of the NPA should be approximately the same as the width of the patient's nostril, while the length should be sufficient to extend from the nostril to the posterior nasopharynx, just above the epiglottis, without causing excessive irritation or trauma [16].

The presence of the NPA can help widen the nasal passage and provide a clear pathway for the subsequent insertion of the endotracheal tube during nasotracheal intubation [17]. The NPA can significantly reduce the risk of trauma to delicate nasal structures by creating a stabilized guiding channel, such as the Kiesselbach's plexus, which is a highly vascular region of the anterior nasal septum that is particularly vulnerable to bleeding during intubation [11].

Indications for NPA depend on the fact that the nasal route is often the first and, sometimes, only option for stabilizing the airway, in emergency and critical care settings. Other indications include maxillofacial surgery or dental procedures, awake intubation, post-operative airway management, strong gag reflexes, limited mouth opening, macroglossia, cervical spine instability, severe cervical kyphosis, severe arthritis, intraoral masses, pathological abnormalities, trismus, and angioedema. The NPA can serve as an important adjunct in managing patient airways in a variety of clinical scenarios, particularly when conventional methods of intubation or ventilation prove challenging or ineffective [2].

Potential factors that may limit the use of a nasopharyngeal airway include basilar skull fractures, epiglottitis, facial trauma, disruption of the midface, nasopharynx or roof of the mouth, the presence of large nasal polyps, recent nasal surgery, coagulation disorders, and the use of

anticoagulant medications. These conditions can predispose patients to an increased risk of nasal hemorrhage due to impaired hemostasis [18].

The procedure of NPA involves lubricating the device at the first step with a water-soluble gel. Then, it is gently inserted along the floor of the nasal cavity, directing the tube posteriorly and inferiorly toward the oropharynx. The smallest suitable size NPA should be used to minimize trauma. The length of NPA advanced in the nostril can be measured by placing it along the external nasal contour from the nostril to the tragus of the ear. The tragus is a small, cartilaginous projection on the outer ear that serves as a useful anatomical landmark for estimating the appropriate depth of insertion for the nasopharyngeal airway [16]. The NPA should be guided gently along the nasal floor, avoiding contact with the highly vascular nasal septum and turbinates. Proper positioning is confirmed when the distal end of the inserted NPA is visualized in the posterior oropharynx, indicating that the device has been correctly advanced through the nasal cavity and into the nasopharynx.

Conversely, some healthcare providers contend that utilization of a nasopharyngeal airway may heighten the risk of nasal mucosal injury and obstruction of the nasal passages. Additionally, the extra step of inserting the nasopharyngeal airway before intubation could potentially prolong the intubation procedure and overall process duration. However, the potential benefits of reduced epistaxis and improved intubation success rates, as well as the relatively simple and straightforward nature of nasopharyngeal airway insertion, appear to outweigh these potential drawbacks [2].

The literature on the effectiveness of nasopharyngeal airways in reducing epistaxis during nasal intubation is inconclusive. Some studies suggest benefits and others find no significant difference

[19, 20]. To clarify the benefits or potential drawbacks of using a nasopharyngeal airway during nasal intubation, this study aimed to assess the incidence and severity of epistaxis when using a nasopharyngeal airway compared to nasal intubation without the use of a nasopharyngeal airway.

Materials and Methods

Patients and study design

A randomized controlled trial was conducted in 60 patients undergoing elective maxillofacial surgery requiring nasal intubation at Imamein-Kadhimen Medical City from January 2024 to June 2024 at the Department of Oral and Maxillofacial Surgery to evaluate the effectiveness of using a nasopharyngeal airway in reducing the incidence or the severity of epistaxis at two separate times: post-intubation and post-extubation. Patients were randomly assigned to the nasopharyngeal airway group (NPA)(30 patients) and the control group (30 patients) who underwent standard nasal intubation without using the nasopharyngeal airway. In both study groups, a topical vasoconstrictor (xylometazoline hydrochloride 0.05%) was administered to the nasal mucosa via nasal spray to mitigate the risk of bleeding, and the endotracheal tube (ETT) was lubricated with xylocaine gel before insertion. The patient's patent nostril was determined by the history taken regarding breathing difficulties and exam findings by the ear, nose, and throat (ENT) surgeon. The right-side nostril was chosen mostly, which is confined to research conducted by Sato *et al.* (2020) [21].

Inclusion and exclusion criteria

The study included adult patients aged 18 to 65 years who were scheduled for elective maxillofacial surgery requiring nasal endotracheal intubation and those who were required to have an ASA physical status classification of I or II. Excluded patients include those with a history of difficult intubation, coagulation disorders (e.g., hemophilia, Von Willebrand's disease, vitamin K deficiency, etc.), those on anticoagulant therapy (e.g., aspirin, warfarin, etc.), and patients with nasal disorders (e.g., nasal polyps, deviated septum, and nasal obstruction) or with previous nasal surgery (e.g., rhinoplasty, and septoplasty). These exclusion criteria were implemented to ensure the study population was relatively homogeneous and to minimize potential confounding factors that could influence the outcomes related to epistaxis during NTI.

Data collection

Data of age, sex, weight, and the American Society of Anesthesiologists (ASA) physical status classification (to assess overall health) were collected. A medical history was also recorded focusing on conditions that could influence bleeding risk (e.g., bleeding disorders), and a previous history of epistaxis, medications (specifically anticoagulants or antiplatelets,) and relevant comorbidities (e.g., hypertension, bleeding disorders) were collected. The most patented nostril site was determined. Document for any history of nasal trauma, surgery, or anatomical abnormalities was also recorded.

ENT Surgeon Examination

Before the surgical procedure, all patients undergo a pre-operative assessment by an ENT surgeon. This assessment includes a thorough examination of the nasal anatomy and an evaluation of the visibility of the vocal cords. The purpose is to identify any anatomical factors (e.g., nasal polyps,

and septum deviation) that could potentially obstruct the view of the larynx during the nasal intubation process. Based on the findings of this assessment and the individual patient's characteristics, the ENT surgeon provided a recommendation regarding the use of the nasal intubation route, mentioning the most patent nostril among other findings.

General Anesthesia Administration

Before the administration of anesthetic agents, standard monitoring devices were attached to the patient to ensure continuous assessment of vital signs throughout the procedure. These included an electrocardiogram (ECG) to monitor cardiac activity, a non-invasive blood pressure (NIBP) to measure blood pressure, and a pulse oximeter (SPO_2) to continuously monitor the levels of the patient's oxygen saturation. Intravenous access was established to allow for the administration of necessary medications and fluids during the surgery. The patient was then pre-oxygenated with 100% oxygen for 3-5 minutes using a proper fit mask to denitrogenate the lungs and ensure adequate oxygen stores prior to the induction of anesthesia. Premedication given to patients using metoclopramide (10 mg), and dexamethasone (8 mg).

Anesthesia was induced using a combination of ketamine (1 mg/kg), propofol (1-2.5 mg/kg), midazolam (0.01 mg/kg) and rocuronium (0.6 mg/kg). The doses were adjusted according to the patient's weight and individual response. Ketamine was administered first for its analgesic properties. Additional doses of fentanyl (1 mcg/kg) as required. Protocol followed to induce a state of unconsciousness, and rocuronium was used to achieve muscle relaxation. Anesthesia was maintained with a balanced technique using inhalational agents (sevoflurane 2 MAC), titrated to the depth of anesthesia and the patient’s physiological responses.

After the surgical procedure, the inhalational anesthetic agent was discontinued. The residual neuromuscular blocking agent was then reversed with a combination of neostigmine (2.5 mg) and atropine (1 mg). The patients were monitored throughout the recovery process until they met the criteria for extubation, at which point the endotracheal tube was removed.

Protocol of nasal intubation

In the NPA group, before induction of anesthesia, nasal vasoconstrictor (oxymetazoline 0.05%) was sprayed into both nostrils, after achieving an adequate level of anesthesia. Muscle relaxation, a properly sized NPA was selected for the most patent nostril, as determined by the pre-operative ENT assessment. The NPA was lubricated with a xylocaine gel and gently inserted along the floor of the nasal cavity, directing the tube posteriorly and inferiorly towards the oropharynx. The NPA was kept in place for approximately two minutes to allow for a widening of the nasal passages and displacement of the turbinates and soft tissues. This was done to create a smoother and more direct pathway for passage of the endotracheal tube, meanwhile, a proper size mask was tightly fitted on the patient's face with bag ventilation. Once the necessary time had elapsed, NPA was carefully removed, and nasal intubation was performed by gently advancing the lubricated ETT into the most patent nostril and through the nasal cavity in an anti-clockwise direction under direct laryngoscope visualization. The introduction of Magill’s forceps into the oropharynx was followed to manipulate the tip of the endotracheal tube and guide it into the trachea. At the end of the surgery when the patient met the criteria for extubation, ETT disconnected from the ventilator, the ETT cuff deflated and gently withdrawn from the nose.

In the control group, nasal intubation was performed without using an NPA. The standard method was applied by using local vasoconstrictor spray into both nostrils. Upon attaining a sufficient

level of anesthesia, the ETT was lubricated and carefully inserted into the most unobstructed nostril, as advised by the ENT surgeon. It was advanced in a counterclockwise manner until the tube's tip was visible in the oropharynx via a laryngoscope. Subsequently, Magill's forceps were employed to maneuver the tip and direct it into the trachea. The extubation procedure for the NPA group was executed similarly at the conclusion of the operation.

The effectiveness of the procedure in both groups was evaluated using capnography and auscultation to determine equivalent breath sounds on both sides. The occurrence and severity of any nasopharyngeal bleeding observed during the passage of the endotracheal tube under laryngoscope visualization were documented.

Outcome measures

The primary outcome measure for this study was the incidence and severity of epistaxis following nasal intubation and after extubation. Epistaxis severity was assessed using an adapted four-point scale (none, mild, moderate, and severe) originally developed by Sugiyama, [22] with the following definitions:

- **None:** No blood was observed on either the surface of the tube or the posterior pharyngeal wall.
- **Mild epistaxis**: Blood apparent on the surface of the tube or posterior pharyngeal wall.
- **Moderate epistaxis:** Pooling of blood on the posterior pharyngeal wall.
- **Severe epistaxis**: A large amount of blood in the pharynx impedes nasotracheal intubation and necessitate urgent orotracheal intubation.

Epistaxis was assessed at two critical time points: immediately post-intubation and immediately post-extubation. The immediate post-intubation assessment aimed to capture any bleeding directly

related to the insertion of the endotracheal tube. However, recognizing that the endotracheal tube itself could act as a tamponade, potentially masking bleeding from injuries sustained during insertion. A second assessment was conducted immediately following extubation. This allowed for the detection of any bleeding that may have been concealed by the presence of the tube and provided a more comprehensive evaluation of the incidence of epistaxis associated with nasotracheal intubation. By examining the differences in the incidence and severity of epistaxis between the NPA group and the control group, the study aimed to evaluate the effectiveness of using a nasopharyngeal airway in reducing the risk of epistaxis during and after nasal intubation procedures.

Statistical analysis

Statistical analysis was performed using appropriate methods. The data was entered into a Microsoft Excel spreadsheet and then transferred to IBM SPSS version 29 for statistical analysis. The p-value of less than 0.05 was considered statistically significant. Tables included descriptive statistics (number and frequency, averages, and standard deviations), estimates of statistical significance (Chi-square and Fisher exact), and tests of statistical significance (Student t-test and Mann-Whitey U test) for categorical and non-parametric data, respectively. A generalized estimating equations model with a cumulative logit link was used to compare the incidence and severity of epistaxis between the groups. Categorical variables were reported as frequencies and percentages, and continuous variables were reported as means and standard deviations or medians and interquartile ranges, as appropriate.

Results and Discussion

Demographic and Procedural Characteristics

The demographic characteristics of both groups (NPA and control groups) are determined (Table 1). There were no statistically significant differences between the groups in terms of age (p = 0.07), weight (p = 0.06), or ASA status (p = 0.55). However, a slightly higher proportion of male patients were present in the control group (73.3%) than in the NPA group (63.3%), though this difference was not statistically significant (p = 0.51). In general, there were no statistically significant differences in age, weight, or ASA status between the groups, while, a slightly higher proportion of male patients were present in the control group without statistically significant.

Table 1: Comparative demographic data between control and NPA groups

Parameters	**NPA group (n = 30)**(%)	**Control group (n = 30)**(%)	**Test applied**	**P-value**
Age (year)	31.8 ± 12.58	30.66 ± 12.11	t = 0.349	0.07
Weight (kg)	70.16 ± 9.1	73.83 ± 5.33	t = -1.90	0.06
Male	19 (63.3)	22 (73.3)	χ^2 = 30	0.51
Female	11 (36.6)	8 (26.66)		
ASA status I	24 (80)	21 (70)	χ^2 = 0.35	0.55
ASA status II	6 (20)	9 (30)		

Mean ± SD, or n (%), P < 0.05 considered as significant

ASA: American Society of Anesthesiologist, NPA: Nasopharyngeal airway

The nostril choice and endotracheal tube size distribution between the groups were identified (Table 2). The right nostril was preferred in both groups, with no statistically significant difference observed (p = 0.22). Similarly, the distribution of ETT sizes did not differ significantly between the groups (p = 0.4386). Thus, the right nostril was preferred for intubation in both groups, with no significant difference observed. Similarly, the distribution of ETT sizes did not differ

significantly between the groups. These findings suggest that the observed differences in epistaxis rates are likely attributable to NPA use rather than variations in patient demographics or procedural factors.

Table 2: The nostril choice and the ETT size

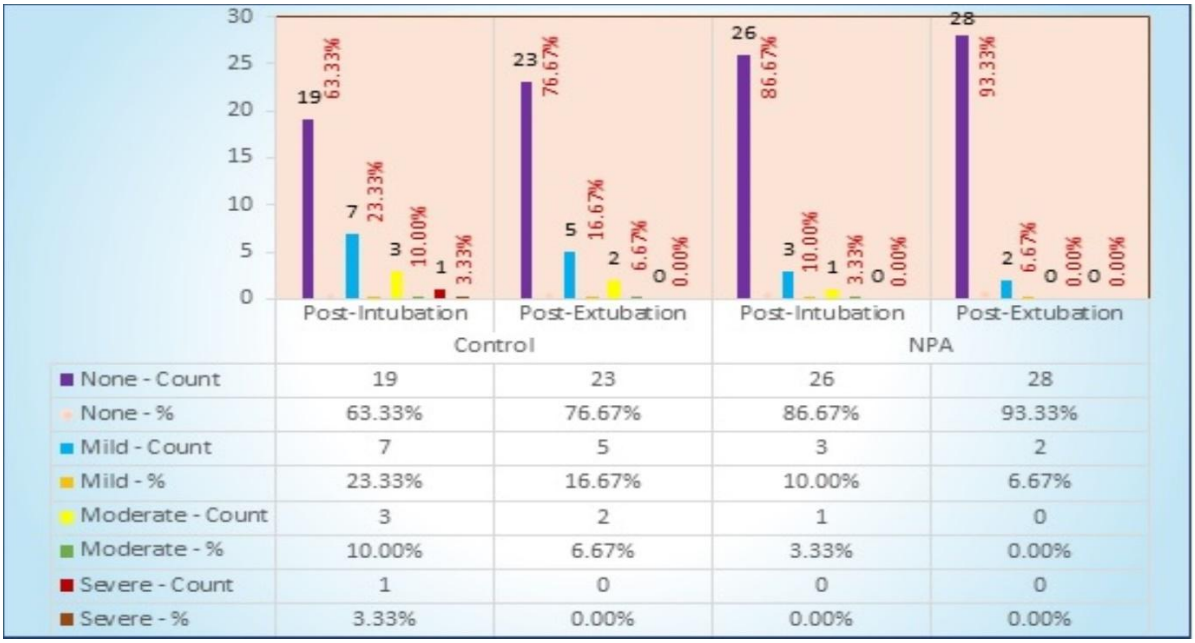
Parameters	NPA group (n = 30)	Control group (n = 30)	Test applied	P-value
Nostril choice: Right	25 (83.33)	21 (70)	χ^2 =1.49	0.22
Left	5 (16.66)	9 (30)		
ETT size (mm ID)				
6.5	13 (43.33)	16 (53.33)	χ^2 = 0.6	0.4386
7.0	17 (56.66)	14 (46.6)		

Data presented as n (%); P < 0.05 considered as significant

ETT: Endotracheal tube, NPA:Nasopharyngeal airway

Epistaxis Severity Distribution

In the control group, the post-intubation showed that the control group exhibited a higher tendency for epistaxis after intubation. One patient (3.3%) experienced severe epistaxis, three (10%) moderate, and seven (23.3%) mild. The remaining 19 patients (63.3%) did not exhibit any bleeding. The post-extubation showed that there was a decrease in epistaxis in the control group upon extubation time. Two patients (6.67%) presented with moderate epistaxis, five (16.67%) with mild, and the majority of patients (23 patients, 76.67%) did not show any epistaxis (Figure 1).



	Control		NPA	
None - Count	19	23	26	28
None - %	63.33%	76.67%	86.67%	93.33%
Mild - Count	7	5	3	2
Mild - %	23.33%	16.67%	10.00%	6.67%
Moderate - Count	3	2	1	0
Moderate - %	10.00%	6.67%	3.33%	0.00%
Severe - Count	1	0	0	0
Severe - %	3.33%	0.00%	0.00%	0.00%

Figure 1: Chart comparing between control group and NPA group on the epistaxis severity after intubation and extubation.

In the NPA group, the post-intubation showed that the NPA group demonstrated a notably lower incidence of epistaxis after intubation. Only one patient (3.3%) experienced moderate epistaxis, three (10%) mild, and a significant majority (26 patients, 86.67%) had no bleeding. The post-extubation showed that this trend of reduced epistaxis in the NPA group continued upon extubation. Two patients (6.67%) presented with mild epistaxis, while the remaining 28 (93.3%) experienced none (Table 3)(Figure 1).

Table 3: Association between group and occurrence of epistaxis

Time	Variable	NPA group, n (%)	Control group, n (%)	Test	P-Value
Post intubation	Epistaxis: Present	4 (13.3%)	11 (36.6%)	χ^2 =4.356	0.037
	Absent	26 (86.6%)	19 (63.3%)		
Post extubation	Epistaxis: Present	3 (6.6%)	7 (23.3%)	χ^2 =3.268	0.071
	Absent	(93.3%) 28	23 (76.6%)		

Data presented as n (%); P < 0.05 considered as significant
NPA: Nasopharyngeal airway

The study's findings revealed a statistically significant association between the use of an NPA and a reduced incidence of epistaxis immediately following intubation. Specifically, the control group, exhibited a significantly higher proportion of patients experiencing epistaxis post-intubation (36.6%) compared to the NPA group (13.3%), as evidenced by the chi-square analysis ($\chi2 = 4.356$, $p = 0.037$). This suggests that NPA utilization was beneficial for the NPA group after intubation. However, this association was not observed at the post-extubation stage. While the control group continued to demonstrate a numerically higher proportion of patients with epistaxis (23.3%) compared to the NPA group (6.6%), this difference did not reach statistical significance ($\chi2 = 3.268$, $p = 0.071$) (Table 3).

Epistaxis severity was assessed using an adapted four-point scale (none, mild, moderate, severe) originally developed by Sugiyama [23], with the following definitions: none as no blood observed on either the surface of the tube or the posterior pharyngeal wall, mild epistaxis as blood apparent on the surface of the tube or posterior pharyngeal wall, moderate epistaxis as pooling of blood on the posterior pharyngeal wall, and severe epistaxis as a large amount of blood in the pharynx

impeding nasotracheal intubation and necessitating urgent orotracheal intubation. Epistaxis was assessed at two critical time points: immediately post-intubation and immediately post-extubation. The immediate post-intubation assessment aimed to capture any bleeding result from the insertion of the endotracheal tube. However, recognizing that the endotracheal tube itself could act as a tamponade, potentially masking bleeding from injuries sustained during insertion. The second assessment was conducted immediately following extubation. This allowed for the detection of any bleeding that may have been concealed by the presence of the tube, providing a more comprehensive evaluation of the incidence of epistaxis associated with nasotracheal intubation.

Epistaxis incidence and severity distribution by a generalized estimating equation (GEE) Test

Epistaxis was the primary outcome observed, which was assessed at two time points, immediate post-intubation and post-extubation. We evaluated both the incidence (presence or absence), and severity of epistaxis based on using a 4-point ordinal scale (none, mild, moderate, and severe).

A generalized estimating equations (GEE) model with a cumulative logit link was used. The GEE analysis revealed a statistically significant difference in epistaxis between the groups (p=0.002). The odds of experiencing any level of epistaxis (mild, moderate, or severe) were 4.06 times greater in the control group compared to the NPA group (95% CI: 1.64 to 10.05) (Table 4). This indicates that the NPA group had a significantly lower incidence of epistaxis overall. Additionally, the odds ratio demonstrates that when epistaxis occurred in the NPA group, it was less likely to be severe compared to the control group.

Table 4: Parameter estimates of epistaxis based on GEE model

Parameter		B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
				Lower	Upper	Wald Chi-Square	df	P-value		Lower	Upper
Epistaxis	**Mild**	2.632	0.5338	1.586	3.679	24.317	1	<.001	13.908	4.885	39.597
	Moderate	4.102	0.5994	2.927	5.277	46.845	1	<.001	60.469	18.680	195.751
	Severe	6.135	1.0154	4.145	8.125	36.508	1	<.001	461.882	63.127	3379.478
Control group		1.402	0.4622	.496	2.308	9.203	1	.002	4.064	1.643	10.055
NPA group		0[a]	.	.	.	.	.	.	1	.	.
Post-Intubation		0.723	0.5572	-0.369	1.815	1.684	1	0.194	2.061	0.691	6.142
Post-Extubation		0[a]	.	.	.	.	.	.	1	.	.
Scale		1									

Dependent Variable: Epistaxis severity (ordinal scale)

Model: Generalized Estimating Equations with a cumulative logit link.

a: The model includes parameters for Epistaxis severity thresholds, group, and time. The coefficient for the lowest level of Epistaxis Severity, the control group, and the post-intubation time point are constrained to zero in the model. These serve as the reference categories for comparison. Other parameter estimates represent the difference in the log-odds of epistaxis relative to these reference categories.

There was no statistically significant difference in the overall severity of epistaxis between the post-intubation and post-extubation time points (p = 0.194). According to the results, it can be suggested that NPAs not only reduce the overall occurrence of epistaxis, but also mitigate the severity of bleeding complications. In contrast, previous studies have suggested a potential benefit of NPAs in reducing nasal trauma during intubation, Dhakate *et al.* (2020) conducted a similar study and found that the use of NPAs before intubation significantly decreased the incidence of epistaxis [2]. Their study reported an epistaxis rate of 6.7% in the NPA group compared to 31.7% in the control group, highlighting a substantial reduction in bleeding complications. This aligns

with this study's findings, where the NPA group exhibited a considerably lower incidence of epistaxis, particularly during the critical intubation phase. Another study by Ban *et al.* (2024) also supported the benefits of NPAs in reducing epistaxis during nasotracheal intubation [24]. They observed a significant decrease in epistaxis rates from 30% in the control group to 12% in the NPA group, reinforcing the consistent trend observed across multiple studies. Elwood *et al.* (2002) conducted a randomized study comparing two methods of nasotracheal intubation [23]. Their findings indicated that the use of a nasopharyngeal airway was associated with a reduced incidence of epistaxis compared to the control group. Demographic factors, such as age, weight, snoring history, and difficulty of intubation, were found to be comparable between the study groups. However, the researchers observed a lower occurrence of obvious bleeding when utilizing the red-rubber catheter technique, although this method required a longer duration to perform. Their findings were consistent with our results with the need to further validate the role of NPAs in mitigating nasal trauma during nasotracheal intubation.

Moreover, Abrons *et al.* (2017) found in their study that using the bougie technique was associated with significantly less nasopharyngeal bleeding than the conventional technique at both 60–90 seconds (55% vs. 68%; $p = 0.033$) and 5 minutes (51% vs. 70%; $p = 0.002$) [25]. The severity of bleeding was also significantly less with the bougie technique, with an OR for active bleeding of 0.42 (95%CI 0.20–0.87; $p = 0.020$) at 60–90 seconds and 0.15 (95%CI 0.06–0.37; $p < 0.0001$) at 5 minutes. Magill forceps were needed significantly less often with the bougie technique (9% vs. 28%, $p = 0.0001$) with no difference in first attempt and overall success rates between the two techniques ($p = 0.133$ and $p = 0.750$, respectively). Not only is nasal intubation over a bougie as successful as the conventional technique, but it also significantly decreases both the incidence and severity of nasopharyngeal trauma, as well as the need for the use of Magill forceps. While the use

of a bougie was not part of our study protocol, Magill forceps were consistently required among all participants. Abrons *et al.* (2017) also showed different methods used, while the method of this study found that utilized NPA far less incidence of epistaxis (13.3%) [25].

Based on Dilek et al., a total of 70 patients were included in the study and divided into 2 groups [26]. There was no statistically significant relationship between the duration of NTI and other variables, but the significance value for sternomental distance, ventilation difficulty, and epistaxis was $P < 0.10$. The NTI duration (the primary outcome variable) and the number of attempts (the secondary outcome variable) are statistically lower in the nasal airway group (group 1) than in the control group (group 2). Ventilation difficulty was significantly higher in group 2 when compared with group 1 ($P = 0.04$). The model and regression coefficients for both variables are statistically significant in terms of duration of NTI and number of attempt values which were lower in the nasal airway group than the control group. There were no statistically significant differences between the groups in terms of complications ($P < 0.05$). While the current study did not directly evaluate the ease of nasotracheal intubation. It was observed that the delicate insertion of the endotracheal tube was a contributing factor to the reduction in epistaxis incidence and severity in the nasal airway group. Moreover, Dilek *et al.* results confirm the findings of the present study, where the use of NPA showed statistical evidence of improvement and minimizing the risk of epistaxis.

Another study by Karim *et al.* (2023) about nasotracheal intubation was done on 900 patients [27]. The majority of patients 891(99.0%) had successful nasotracheal intubation. The patients in this study ranged in age from 10 to 60 years old and the majority were males 685 (76.1%). A small percentage of patients reported postoperative complications such as runny nose 12 (1.3%), epistaxis or nasal bleeding 10 (1.2%), nasal trauma or pain 12(1.3%), inflammation or ulceration of the nose with full recovery 6 (0.6%), and sinusitis 10 (1.2%) among individuals. For atraumatic

nasotracheal intubation, nasal cavity dilatation with nasopharyngeal airways was useful. Dilatation of the nasal cavity with nasopharyngeal airways (NPAs) extensively eases the insertion of endotracheal tube (ETT) into the nasopharynx and significantly decreases the incidence and severity of trauma and bleeding during nasotracheal intubation. These findings confirmed the results of the present study on the efficacy of the use of NPAs before nasotracheal intubation to reduce epistaxis.

Enk *et al.* (2002) assumed that nasopharyngeal passage of an endotracheal tube may be facilitated by a nasopharyngeal airway (Wendl tube) acting as a "pathfinder" [28]. Accordingly, a randomized, controlled trial with a blinded assessment of nasopharyngeal bleeding and contamination of the tip of the endotracheal tube was performed in the present study. After the induction of anesthesia, a Wendl tube (28 Ch) was inserted into the more patent nostril. In the control group (n = 30), the Wendl tube was retrieved before the nasopharyngeal passage was attempted with an endotracheal tube (inner diameter, 7.0 mm). In the intervention group (n= 30), the Wendl tube was kept in position and only its adjustable flange was removed. Then, inserted the tip of the endotracheal tube into the trailing end of the Wendl tube. Subsequently, the endotracheal tube was advanced under visual control to the oropharynx guided by the Wendl tube. After the endotracheal tube was positioned in the oropharynx, the Wendl tube was removed and intubation was completed. Six hours after surgery, the patient's nasal pain was determined. The "pathfinder" technique reduced the incidence ($P<0.001$) and severity ($P = 0.001$) of bleeding, decreased tube contamination with blood and mucus ($P < 0.001$), and diminished postoperative nasal pain ($P = 0.036$).

The mechanism behind this protective effect likely involves the ability of NPAs to widen the nasal passages and displace soft tissues, creating a more direct and less traumatic pathway for

endotracheal tube passage. This reduces friction and pressure on the delicate nasal mucosa, minimizing the risk of injury and subsequent bleeding. Furthermore, this study's rigorous methodology, including the randomized controlled design and the use of a generalized estimating equations model, strengthens the validity of the present findings. The lack of significant differences in demographic characteristics and procedural factors between the groups further supports the conclusion that the observed reduction in epistaxis severity is directly attributable to the use of the NPAs.

It is important to note that one case in the control group had severe epistaxis necessitated a shift to oral intubation and surgical intervention. This instance underscores the potential for significant bleeding complications, albeit rare, during nasotracheal intubation. Although this patient was successfully re-intubated nasally after treatment with no more experienced epistaxis, this case highlights the importance of proactive measures like prophylactic NPA placement to minimize such events. Further research with larger sample sizes could explore factors associated with successful re-intubation following epistaxis management.

The clinical implications of this study's findings are substantial. These complications of epistaxis include difficult airway management, scenario of difficult intubations, and potentially delaying surgical procedures or necessitating interventions like pressure application using pack, suctioning, vasoconstrictors, or even more invasive measures like cauterization, and surgical intervention [2, 5, 6]. By proactively mitigating this risk, prophylactic NPA placement emerges as a simple yet powerful tool to enhance patient comfort, streamline anesthetic management, and optimize surgical workflow. This is particularly relevant in settings where resources might be limited, or delays carry higher stakes.

Conclusions

This study provides compelling evidence that prophylactic NPA placement is a simple, low-cost, and easily implemented intervention with significantly reduces the incidence and severity of epistaxis that could be associated with nasotracheal intubation. This translates to a tangible benefit for patients undergoing procedures requiring this common airway management technique. Several recommendations can be excluded from this study. The routine use of prophylactic nasopharyngeal airway placement for patients undergoing nasotracheal intubation can effectively minimize the risk of epistaxis complications, except in cases where contraindications exist. An enhancement of larger and diverse patient populations can be obtained based on the generalizability of the results and provide insights into the effectiveness of NPAs across different patient demographics and clinical settings. Assessing the impact of NPAs on other potential complications, such as nasal mucosal trauma or patient discomfort, would provide a more comprehensive understanding of its safety profile. The underlying pathophysiology and mechanisms behind epistaxis during nasotracheal intubation are likely to be similar across healthcare settings, supporting the generalizability of the intervention. However, further multi-center studies could confirm the effectiveness of prophylactic NPA placement in diverse clinical environments.

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