International Journal of Current Pharmaceutical Research

ISSN- 0975-7066 Vol 16, Issue 4, 2024

Original Article

EFFECT OF BEVEL DIRECTION OF THE ENDOTRACHEAL TUBE ON THE PROPORTION OF CASES DEVELOPING EPISTAXIS DURING NASOTRACHEAL INTUBATION-A RANDOMIZED CONTROLLED INTERVENTIONAL STUDY

YOGESH CHAND MODI, NGURANG MENIA, ANCHAL JHAWER*

Department of Anaesthesiology, Sawai Mansingh Medical College and Attached Hospitals, Jaipur, Rajasthan, India
***Corresponding author: Anchal Jhawer; Email: jhaweranchal@gmail.com**

Received: 15 Apr 2024, Revised and Accepted: 04 Jun 2024

ABSTRACT

Objective: Nasotracheal intubation is associated with a number of complications, most commonly nasal trauma or epistaxis. The aim of the study is to determine the effect of conventional versus cephalad direction of the bevel of endotracheal tube on the development of epistaxis during nasotracheal intubation.

Methods: A total of 74 adults aged 18 to 50 y posted for surgeries requiring nasotracheal intubation were randomly divided into group A (Conventional) and group B (Interventional). After induction of anesthesia, in group a bevel direction of thermo softened PVC endotracheal tube was towards the nasal septum in the nasal passage and cephalad in group B, later nasotracheal intubation was completed with direct laryngoscopy and Magill forceps. After five minutes direct laryngoscopy was done to check for presence of epistaxis and its severity. Degree of resistance, nasal passage time, intubation time and haemodynamic parameters (heart rate, blood pressures) were also assessed and compared.

Results: The incidence of epistaxis was significantly lower in group B (Interventional) than group A (Conventional) [15 vs 27; p-value = 0.005], severity of epistaxis [0/1/2] were also significantly lower in group B [22/12/3] than group A [10/15/12] [p value = 0.001]. There was significant difference in haemodynamic parameters between both groups at 1 min till 7 min post intubation. There was no significant difference in degree of resistance, nasal passage time and mean intubation time.

Conclusion: The cephalad direction of the bevel of endotracheal tube in nasal passage during nasotracheal intubation decreases the chances of developing epistaxis and its severity. Hemodynamic parameters are also more stable in cephalad direction.

Keywords: Nasotracheal intubation, Bevel, Endotracheal tube, Epistaxis, Cephalad, Laryngoscopy

DOI: https://dx.doi.org/10.22159/ijcpr.2024v16i4.5028 Journal homepage: https://innovareacademics.in/journals/index.php/ijcpr

INTRODUCTION

Airway management of various head and neck surgeries requires intubation via nasal route. In nasotracheal intubation (NTI) the tracheal tube passes through nasal cavity allowing better isolation and good surgical access for the operating surgeon. The nasotracheal intubation conventionally has been performed by passing the standard left-facing bevel endotracheal tube blindly in the vessel-rich narrow nasal cavity which are divided into sections by turbinates [1] and then the tube, once it reaches the oropharynx is guided into the glottis using direct laryngoscopy with or without the assistance of Magill forceps [2].

The most common complication of blind introduction of tube into the nasal cavity is epistaxis with an incidence of 18 to 88% [2-5]. Both endotracheal tube and its cuff can injure the nasal mucosa and the structures (e. g., turbinates) of the nasal cavity. Epistaxis after NTI in most of the cases is minor but in severe cases may render tracheal intubation impossible [5]. Other complications such as accidental partial or complete turbinectomy, retropharyngeal wall laceration or perforation, inferior turbinate ulceration, bacteraemia, cranial bone fracture leading to CSF rhinorrhoea, olfactory nerve injury, partial or complete obstruction of tube by avulsed tissues, sinusitis, nasal ala pressure sores or necrosis, may occur[1] [6-10]. Thus, reducing the potential complications during NTI is a challenge. The presence of asymptomatic nasal pathologies, most commonly septal deviation and septal spurs, increase the risk of these injury further during NTI [11].

Two main pathways are available in the nasal cavity through which a tracheal tube can pass: the upper pathway and the lower pathway. The upper pathway is located between the middle and inferior turbinates; the lower pathway is beneath the inferior turbinate and immediately above the nasal floor. The lower pathway is considered safer than upper pathway as it decreases the risk of injury to the middle turbinate and epistaxis [4]. [Fig. 1].

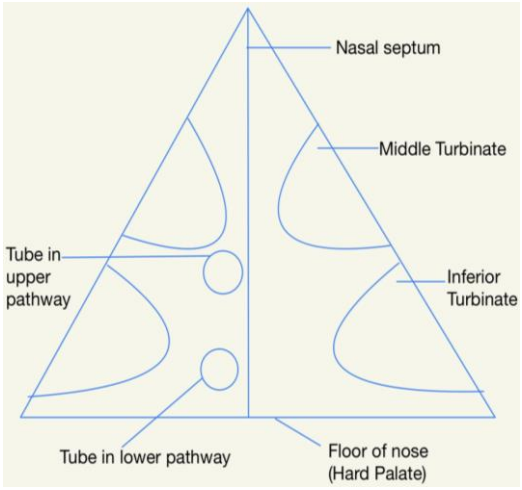


Fig. 1: Pathways for the tube in the nasal cavity

There has been several studies done for the selection of lower pathway in the nasal cavity for the tube by use of a reinforced tracheal tube, a nasogastric tube, fibreoptic endoscope guided NTI and nasal tip lifting maneuver [2, 4, 1, 13]. Several methods such as using vasoconstrictor nasal drops, prior thermo softening, lubrication of tube with water soluble jelly, choosing appropriate tube size, selection of most patent nostril by prior nasal endoscopy, sheathing the tube with a softer material, softer tube material e. g. ivory portex tube, blunt tip (Magill tip), using parker flex tip endotracheal tube, silicone tracheal tube, red rubber catheter or urethral catheter assisted NTI,

bougie guided NTI, dilating incrementally with nasopharyngeal tubes [14-30] may help to minimize complications like epistaxis. As no single method provides complete protection against epistaxis, they are usually done simultaneously.

In the lateral wall of the nasal cavity the turbinates especially the middle turbinate, poses the risk of injury and epistaxis. In the medial wall of the nasal cavity (Septum) injury to the little's area can cause epistaxis. So during conventional NTI with bevel facing patient's left, the septum in the left nostril and in the right nostril the turbinates might be injured. We hypothesized that the incidence of epistaxis would be lower if the bevel direction of the standard endotracheal tube is kept cephalad during NTI as the septum and turbinates are free from the leading edge (tip) and bevel of the endotracheal tube. This study aimed to asses and compare the proportion of cases developing epistaxis, severity of epistaxis, degree of resistance encountered in the nasal cavity, nasal passage time, mean intubation time and haemodynamic parameters between conventional and cephalad direction of bevel in the nasal cavity.

MATERIALS AND METHODS

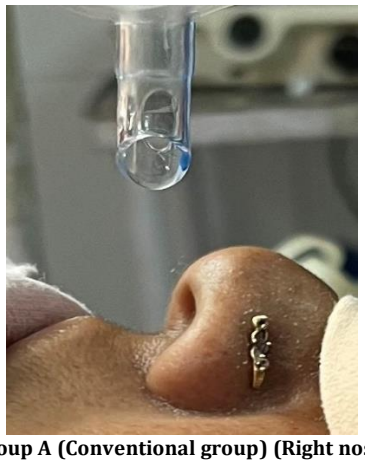
The study protocol was approved by the institutional ethics committee (229/MC/EC/2021) in accordance with the Declaration of Helsinki and registered at Clinical Trial Registry of India (CTRI/2022/03/041456). Written informed consent was obtained from each participant.

This hospital-based randomized controlled interventional study was conducted between April 2022 and August 2022. A total of 74 patients aged between 18 to 50 y of both genders ASA I and II undergoing elective surgeries requiring Nasotracheal intubation with MPG 1 and 2 having at least 2 finger mouth opening and were able to easily breathe through both nostrils at tertiary care Hospital were recruited after informed written consent. Preoperatively nasal patency test was done by external inspection of the nares size, spatula test and nose block test by asking the patient to breathe from the nostrils one at a time and were asked regarding the ease of breathing. Exclusion criteria included patient with known deformities of the nasal cavity, mass in the nasal cavity, nasopharynx and oropharynx, history of severe epistaxis, recurrent epistaxis requiring medical intervention or epistaxis within a month, history of nasal congestion within a month, current coagulation abnormality or history of fracture or operation of cranial base, CSF rhinorrhoea. Patients with any traumatic direct laryngoscopy and injury with Magill forceps were also excluded.

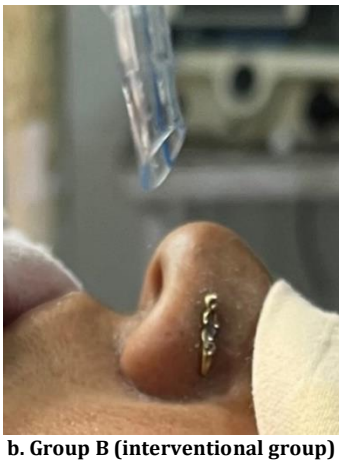
On the day of surgery, patients were randomly allocated to group a (conventional) or group B (interventional) by opaque sealed envelope method. Patients and the assessors who evaluated the epistaxis were blinded to the group allocation. However, the intubating anaesthesiologists could not be blinded to the group allocation as it was not possible to conceal the tracheal tube during NTI.

After confirming at least 8 hours of fasting, two drops of 0.2% xylometazoline was applied to both the nostrils inside the OT. The ECG, non-invasive blood pressure, oxygen saturation and end-tidal carbon dioxide were monitored. After premedication with midazolam 0.05 mg/kg, glycopyrrolate 0.001 mg/kg, fentanyl 2µg/kg and preoxygenation with 100% oxygen for 3 min, induction was done with propofol 2.5 mg/kg. After no verbal response, successful bag and mask ventilation was confirmed and then atracurium 0.5 mg/kg was given and bag and mask were continued for another 3 min. In both the groups, a standard PVC endotracheal tube (7.0 mm ID for male and 6.5 mm ID for female) with left facing bevel was used. Thermo softening was done by immersing the tubes in sterile saline 0.9% maintained at 40 Celsius 10 min prior to use. The tube was lubricated with water-soluble jelly and introduced into the most patent nostril with head extension [31] in all the patients. The nostril side was selected by examination as mentioned earlier and ease of breathing as reported by the patient preoperatively. If patient had equal ease of breathing, then right nostril was selected.

In group A (conventional), the tracheal tube was inserted with the bevel facing towards the patient's nasal septum in the nasal cavity and in the left nostril; once the tube reaches the oropharynx the tube was again rotated to make the bevel face left side of the patient so as to maintain the Magill curvature of the tube in the airway. In group B (interventional group) the tracheal tube was inserted with the bevel facing the patient's cephalad direction in the nasal cavity by rotating the tube 90 anti-clockwise in the right nostril and 90 clockwise in the left nostril from the conventional position in the nasal cavity and then once the tube crossed the posterior nasopharyngeal wall into oropharynx it was turned back to the position where bevel faces left side of the patient [fig. 2].



a. Group A (Conventional group) (Right nostril)



b. Group B (interventional group)

Fig. 2: Bevel direction of the conventional group and the intervention group

In both the groups, the tube was directed along the floor of the nose in caudal direction with cephalad traction of the proximal part of the endotracheal tube with head extended. After the tube had crossed the posterior nasal aperture, the tracheal intubation was completed using Macintosh laryngoscope and Magill forceps, cuff inflated and after the position of the tube was confirmed by capnography and bilateral air entry auscultation, the tube was fixed in the both groups. In both groups, tracheal tube was directed caudally along the floor of the nose so to advance the tube in the lower pathway. In case of resistance the tube was redirected more caudally and if resistance still encountered then the tube was directed slightly more cephalad to find the least resistance pathway to advance the tube.

The resistance encountered in the nasal cavity was graded using the same criteria as Won *et al.* i. e.: 0-slight (when the tube passed nasal cavity smoothly); 1-moderate (when the tube was redirected because of resistance); 2-obstructed (when NTI failed because of

resistance). The procedure time was recorded as nasal passage time from the insertion of the tube into the nostril to the insertion of the direct laryngoscope into the mouth and as nasal intubation time from the insertion of the tube into the nostril to the confirmation of the capnography. The NTI was performed by anaesthesiology residents with more than 2 y of experience in airway management using adequate gentle force.

The presence of epistaxis and severity was evaluated by direct inspection of the mouth and pharynx using gentle direct laryngoscopy done 5 min after the nasal intubation by independent assessors (with same experience) unaware of the intervention done. The severity of nasal bleeding was graded using the same criteria as Won *et al.* i. e.: 0-no epistaxis; 1-mild epistaxis (blood on the tracheal tube only or tinged on the posterior pharyngeal wall); 2-moderate epistaxis (blood pooling in the pharynx); or 3-severe epistaxis (blood in the pharynx sufficient to impede intubation). The hemodynamic parameters (heart rate, blood pressure) were monitored till 10 min after intubation to be compared with the baseline.

A sample of 37 cases in each group are calculated at 95% confidence interval and power of 80% to verify expected difference of 32.3% in proportions of epistaxis episode as per a study done by Won *et al.* in between two study group (group A and group B) to compare the effect of bevel direction on the incidence of epistaxis during nasotracheal intubation.

Nominal/categorical variables were summarised as frequency and percentage and were analysed using Chi square test. Continuous variables were summarised as mean and standard deviation and were analysed using independent sample =t test for comparison between 2 groups. The p value<0.05 was considered as statistically significant. All statistical analyses were done using SPSS version 22 (trial version) and Microsoft office.

RESULTS

All tubes had successfully passed through the first nostril selected smoothly or after redirecting the tubes in the first attempt. No patient had needed any intervention for the nasal bleeding as there was no active blood trickling into the oropharynx during evaluation with laryngoscopy. Spontaneous haemostasis occurred in all the patients with epistaxis. Cormack lehane grade was I or II for all the patients. There was no case of traumatic laryngoscopy and Magill forceps manipulation among the participants. The anaesthesia technique was standardized in all patients.

A total of 74 patients were enrolled in the study, 37 in each group and all the participants completed the study. The demographic data for the 2 groups are reported in table 1. Age, sex, ASA status classification and selected nostril side were comparable between the groups. In majority of patients, Right nostril was selected in both the groups. There was significant difference in heart rate and mean arterial pressure found between both the groups at 1 min till 7 min after NTI as p value was<0.05. The maximum observed value for both heart rate and mean arterial pressure was seen at 1 min post-intubation from their preinsertion values in both the groups. The nasal passage time and nasal intubation time were comparable between the two groups. The resistance encountered were comparable between the two groups. There was more incidence of moderate resistance in group A than group B but it was not found to be significant. The proportion of cases developing epistaxis were significantly lower in group B (Interventional) than group A (Conventional). We found that 27 (72.9 %) patients in group A and 15(40.5%) patients in group B had epistaxis (p=0.005). The severity of epistaxis was also significantly lower in group B than group A. We found that in group A, 15 (40.54%) patients had grade 1(mild) and12 (32.43%) patients had grade 2 (moderate) severity of epistaxis and in group B, 12 (32.4%) patients had grade 1(mild) and 3 (8.11%) patients had grade 2 (moderate) severity of epistaxis (p= 0.001).

Table 1: Patient demographic and characteristics

Demographic data	Group A(Conventional) n = 37	Group B(Intervention) n = 37	p-value
Age mean+/-SD (years)	37.2+/-11.2	34.6+/-11.7	0.32
Gender (male/female)	23/14	20/17	0.48
ASA grade (½)	23/14	30/7	0.069
Nostril side			
Left	15	17	0.5
Right	22	20	0.45

Data are presented as the mean ±standard deviation or number (%). ASA, American Society of Anaesthesiologists status classification

Table 2: Effect of tracheal tube on various study outcomes

Study outcomes	Group A (Conventional)	Group B (Interventional)	p value
Maximum observed Heart rate (beats per minute) after NTI	117.8 (11.4)	103.4 (12.5)	<0.0001
Maximum observed mean Arterial Pressure (mmHg) after NTI	111.2 (6.6)	104.8 (4.8)	<0.0001
Resistance; Slight/Moderate/Obstructed	16/21/0	18/19/0	0.66
Epistaxis	27 (72.9)	15 (40.5)	0.005
Severity of epistaxis; None/Mild/Moderate/Severe	10/15/12/0	22/12/3/0	0.001
Nasal Passage Time (seconds)	10.6 (2)	10.2 (1.8)	0.34
Nasal Intubation Time (seconds)	42.05 (4.12)	41 (4.3)	0.28

Data are presented as the mean ± standard deviation and number (%).

DISCUSSION

Our study is based on the efficacy of bevel direction in nasal cavity in reducing nasal bleed and its severity during nasotracheal intubation. Won *et al.* [5] had utilised the mechanical characteristic of the tracheal tube i. e., bevel direction in nasal cavity to determine the tube pathway as their primary outcome and the incidence of epistaxis and severity as the secondary outcome. Unlike their study, we had used a standard PVC nasal/oral left-facing bevel tube as preformed Mallinckrodt RAE nasal tube is not always available and very expensive.

For all the cases nasal preparation was done with vasoconstrictor nasal drops, thermo softening of the tube was done, lubrication of tube and head extension manoeuvre was done. The anaesthesia technique was standardised in all patients. Both the groups were statistically comparable based on nostril selection.

Previous studies that used Parker Flex-Tip tube, which has posteriorly facing bevel and soft flexible, curved rounded tip, has also shown to decrease trauma to the septum and turbinate, thereby reducing nasal bleeding during nasotracheal intubation as compared to standard left-facing bevel endotracheal tube [28-30]. A study done by Coe *et al.* has also suggested the possibility that rotation of the bevel 90˚ anticlockwise may decrease epistaxis as neither septum nor turbinate would be at risk [11].

In this study we found that Nasotracheal intubation done with facing the bevel of the tracheal tube cephalad to the patient in the nasal cavity decreased the incidence and severity of epistaxis compared with conventional NTI. The overall incidence of epistaxis in our study was 56.7 %. In conventional group the incidence was 27 (72.9%) and in cephalad group it was 15 (40.5%). The severity of epistaxis was also significantly less in cephalad group. Our findings are supported by the study done by Won *et al.* [5] where they found that by changing of the bevel direction towards the patient's cephalad increased the success rate of passing through the lower pathway in nasal cavity and significantly reduced epistaxis and its severity.

There are multiples causes of epistaxis during nasotracheal intubation but trauma to the structures in nasal cavity especially middle turbinate or nasal septum is common. The standard tracheal tube has left facing bevel and the sharper leading edge (tip) on the right; the turbinates are more vulnerable to epithelial injury in the right nostril, whereas in the left nostril the septum is at more risk during conventional NTI with bevel facing patient's left [11]. Some have suggested that bevel is more traumatic for the turbinates. A case report by Knuth TE and Rick JR had suggested to use the right nostril first (the bevel at the tube tip will then point away from the nasal turbinates located laterally and thereby have less opportunity to snag and shear them). If the left nostril is used, the tube should be inserted upside down and then turned once inserted past the turbinates [14]. In our study the bevel faced the patient's nasal septum in conventional group for both right and left nostril so as to keep the bevel away from the turbinates. By keeping the bevel cephalad to patient both septum and turbinates on the lateral wall are avoided from trauma by the leading edge (tip) or bevel in the nasal cavity.

The cephalad orientation of the bevel in nasal cavity might also help to smoothly glide over the sharp curvature of the nasopharynx as compared to the tip impinging on the posterior wall of the nasopharynx. This mechanism may also have contributed to the lower incidence of epistaxis and its severity by reducing injury to nasopharyngeal mucosa. The significantly reduced number of epistaxis and severity among cephalad group in our study may also be because of the passage through the lower pathway as suggested by Won *et al.*[5] that when the posteriorly oriented bevel of the tracheal tube encounters the turbinates, it may act as a wedge to guide the tracheal tube to the lower pathway. However, we could not do fibreoptic examination for the tube pathway.

Fiberoptic guided nasotracheal intubation reduces the incidence of epistaxis than blind nasal intubation by guiding the tube in lower pathway [2] but since fibreoptic bronchoscope is costly, time consuming, needs skill and not available everywhere therefore finding other techniques to reduce the risk of epistaxis during NTI is more useful.

In comparison to Won D *et al.*[5]our study showed more nasal passage time and intubation time for the conventional group (group A) rather than cephalad group (group B) probably because moderate resistance was encountered more in conventional group and in conventional group the tube in the left nostril had to be rotated 180 clockwise or anticlockwise in the oropharynx from the initial position in the nasal cavity in order to maintain left facing bevel and Magill curvature of the tube.

NTI produces hemodynamic instability by mechanical stimulation of the narrow upper airway as the nasotracheal tube is passed through the nose and nasopharynx, resulting in more activation of the sympathetic nervous system and causing an increase in Heart rate and blood pressure [33, 34]. Previous studies done in anaesthetised adults have demonstrated that nasopharyngeal intubation and insertion of a nasopharyngeal airway can produce significant hypertensive responses [35, 36].

We found that hemodynamic parameters (heart rate and mean arterial pressure) were also less variable than the preinsertion values in cephalad group as compared to conventional group. The reason for more hemodynamic stability in cephalad group might be because of the avoidance of direct pressure and trauma by the leading edge (tip) on septum and turbinates, also easy gliding of the cephalad-oriented bevel over nasopharyngeal wall, which leads to less sympathetic stimulation whereas the leading edge (tip) of a standard tube with left or right oriented bevel might impinge on it. A study by Prasanna D *et al.* [6] had suggested to turn the tube ¼ turn after reaching the nasopharynx in conventional method of NTI to overcome resistance in the posterior nasopharynx (thereby leading to less sympathetic stimulation) [6]. However, more studies comparing the effect of bevel direction on hemodynamic parameters during nasotracheal intubation are required.

This study has few limitations. First, blinding the intubating anaesthesiologists to group allocation was not possible. There might have been bias. Also, the interventionist residents were less skilled. The assessors who examined the epistaxis were blinded. Second preoperative and postoperative nasal endoscopy to rule out asymptomatic abnormal nasal pathologies was not done, which could have affected the incidence of epistaxis. Third fibreoptic examination was not done for the pathway of the tube and site of injury/bleeding due to nonavailability.

CONCLUSION

Directing the bevel towards the patient's cephalad can reduce the incidence of epistaxis and its severity during nasotracheal intubation. We suggest that this method be used along with other methods to decrease epistaxis.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

The manuscript has been read and approved jointly by us and requirements as authorship has been met. This article is an original work.

CONFLICTS OF INTERESTS

The authors declare that they have no conflicts of interest

REFERENCES

1. Hall CE, Shutt LE. Nasotracheal intubation for head and neck surgery. Anaesthesia. 2003;58(3):249-56. doi: 10.1046/j.1365-2044.2003.03034.x, PMID 12603455.
2. Tong JL, Tung A. A randomized trial comparing the effect of fiberoptic selection and guidance versus random selection, blind insertion, and direct laryngoscopy on the incidence and severity of epistaxis after nasotracheal intubation. Anesth Analg. 2018;127(2):485-9. doi: 10.1213/ANE.0000000000003396, PMID 29683824.
3. Elwood T, Stillions DM, Woo DW, Bradford HM, Ramamoorthy C. Nasotracheal intubation: a randomized trial of two methods. Anesthesiology. 2002;96(1):51-3. doi: 10.1097/00000542-200201000-00014, PMID 11753001.
4. Kim H, Lee JM, Lee J, Hwang JY, Chang JE. Influence of nasal tip lifting on the incidence of the tracheal tube pathway passing through the nostril during nasotracheal intubation: a randomized controlled trial. Anesth Analg. 2018;127(6):1421-6. doi: 10.1213/ANE.0000000000003673, PMID 30044295.
5. Won D, Kim H, Chang JE, Lee JM, Min SW, Jung J. Effect of bevel direction on the tracheal tube pathway during nasotracheal intubation: a randomised trial. Eur J Anaesthesiol. 2021;38(2):157-63. doi: 10.1097/EJA.0000000000001347, PMID 33009189.
6. Prasanna D, Bhat S. Nasotracheal intubation: an overview. J Maxillofac Oral Surg. Oct-Dec 2014;13(4):366-72. doi: 10.1007/s12663-013-0516-5, PMID 26224998.
7. Chauhan V, Acharya G. Nasal intubation: a comprehensive review. Indian J Crit Care Med. 2016;20(11):662-7. doi: 10.4103/0972-5229.194013, PMID 27994382.
8. Park DH, Lee CA, Jeong CY, Yang HS. Nasotracheal intubation for airway management during anesthesia. Anesth Pain Med. 2021;16(3):232-47. doi: 10.17085/apm.21040.
9. Cavusoglu T, Yazici I, Demirtas Y, Gunaydin B, Yavuzer R. A rare complication of nasotracheal intubation: accidental middle turbinectomy. J Craniofac Surg. 2009;20(2):566-8. doi: 10.1097/SCS.0b013e31819ba378, PMID 19305259.

10. Moore DC. Middle turbinectomy: a complication of improper nasal intubation? Anesthesiology. 2000;92(5):1504-5. doi: 10.1097/00000542-200005000-00061, PMID 10781309.
11. Coe TR, Human M. The peri-operative complications of nasal intubation: a comparison of nostril side. Anaesthesia. 2001;56(5):447-50. doi: 10.1046/j.1365-2044.2001.01524.x, PMID 11350331.
12. Ahmed Nusrath A, Tong JL, Smith JE. Pathways through the nose for nasal intubation: a comparison of three endotracheal tubes. Br J Anaesth. 2008;100(2):269-74. doi: 10.1093/bja/aem350, PMID 18083994.
13. Lim CW, Min SW, Kim CS, Chang JE, Park JE, Hwang JY. The use of a nasogastric tube to facilitate nasotracheal intubation: a randomised controlled trial. Anaesthesia. 2014;69(6):591-7. doi: 10.1111/anae.12627, PMID 24749956.
14. Knuth TE, Richards JR. Mainstem bronchial obstruction secondary to nasotracheal intubation: a case report and review of the literature. Anesth Analg. 1991;73(4):487-9. doi: 10.1213/00000539-199110000-00021, PMID 1897774.
15. Katz RI, Hovagim AR, Finkelstein HS, Grinberg Y, Boccio RV, Poppers PJ. A comparison of cocaine, lidocaine with epinephrine, and oxymetazoline for prevention of epistaxis on nasotracheal intubation. J Clin Anesth. 1990;2(1):16-20. doi: 10.1016/0952-8180(90)90043-3, PMID 2310576.
16. O'Hanlon J, Harper KW. Epistaxis and nasotracheal intubation–prevention with vasoconstrictor spray. Ir J Med Sci. 1994;163(2):58-60. doi: 10.1007/BF02943016, PMID 7515382.
17. Seo KS, Kim JH, Yang SM, Kim HJ, Bahk JH, Yum KW. A new technique to reduce epistaxis and enhance navigability during nasotracheal intubation. Anesth Analg. 2007;105(5):1420-4. doi: 10.1213/01.ane.0000281156.64133.bd, PMID 17959976.
18. Kim YC, Lee SH, Noh GJ, Cho SY, Yeom JH, Shin WJ. Thermosoftening treatment of the nasotracheal tube before intubation can reduce epistaxis and nasal damage. Anesth Analg. 2000;91(3):698-701. doi: 10.1097/00000539-200009000-00038, PMID 10960403.
19. Shanahan E, Yu CV, Tang R, Sawka A, Vaghadia H. Thermal softening of polyvinyl chloride nasotracheal tubes: effect of temperature on tube navigability. Can J Anaesth. 2017;64(3):331-2. doi: 10.1007/s12630-016-0768-x, PMID 27822785.
20. Kim CH, Bahk JH, Park KS. The influence of endotracheal tube tip design on nasal trauma during nasotracheal intubation: Magill-tip versus murphy-tip. Lee JH Anesth Analg. 2005;101:1229.
21. Wong A, Subar P, Witherell H, Ovodov KJ. Reducing nasopharyngeal trauma: the urethral catheter–assisted nasotracheal intubation technique. Anesth Prog. 2011;58(1):26-30. doi: 10.2344/0003-3006-58.1.26, PMID 21410362.
22. Lera S, Machan M, Derefaka G. A safer technique for nasal intubation: a literature review. O J Anes. 2017;07(8):275-85. doi: 10.4236/ojanes.2017.78028.
23. Delgado AV, Sanders JC. A simple technique to reduce epistaxis and nasopharyngeal trauma during nasotracheal intubation in a child with factor IX deficiency having dental restoration. Anesth Analg. 2004;99(4):1056-7. doi: 10.1213/01.ANE.0000133914.26066.99, PMID 15385350.
24. Vadhanan P, Tripaty DK. Effect of bougie-guided nasal intubations upon bleeding: a randomised controlled trial. Turk J Anaesthesiol Reanim. 2018;46(2):96-9. doi: 10.5152/TJAR.2017.51333, PMID 29744243.
25. Ozkan AS, Akbas S, Toy E, Durmus M. North polar tube reduces the risk of epistaxis during nasotracheal intubation: a prospective, randomized clinical trial. Curr Ther Res Clin Exp. 2019;90:21-6. doi: 10.1016/j.curtheres.2018.09.002, PMID 30787962.
26. Adamson DN, Theisen FC, Barrett KC. Effect of mechanical dilation on nasotracheal intubation. J Oral Maxillofac Surg. 1988;46(5):372-5. doi: 10.1016/0278-2391(88)90220-0, PMID 3163370.
27. Kihara S, Komatsuzaki T, Brimacombe JR, Yaguchi Y, Taguchi N, Watanabe S. A silicone-based wire-reinforced tracheal tube with a hemispherical bevel reduces nasal morbidity for nasotracheal intubation. Anesth Analg. 2003;97(5):1488-91. doi: 10.1213/01.ANE.0000082244.93210.2F, PMID 14570671.
28. Sanuki T, Hirokane M, Matsuda Y, Sugioka S, Kotani J. The parker flex-tip tube for nasotracheal intubation: the influence on nasal mucosal trauma. Anaesthesia. 2010;65(1):8-11. doi: 10.1111/j.1365-2044.2009.06123.x, PMID 19849677.
29. Sugiyama K, Manabe Y, Kohjitani A. A styletted tracheal tube with a posterior-facing bevel reduces epistaxis during nasal intubation: a randomized trial. Can J Anaesth. 2014;61(5):417-22. doi: 10.1007/s12630-014-0156-3, PMID 24740408.
30. Prior S, Heaton J, Jatana KR, Rashid RG. Parker flex-tip and standard-tip endotracheal tubes: a comparison during nasotracheal intubation. Anesth Prog. 2010;57(1):18-24. doi: 10.2344/0003-3006-57.1.18, PMID 20331335.
31. Kim H, Lee JM, Lee J, Hwang JY, Chang JE. Effect of neck extension on the advancement of tracheal tubes from the nasal cavity to the oropharynx in nasotracheal intubation: a randomized controlled trial. BMC Anesthesiol. 2019;19(1):158. doi: 10.1186/s12871-019-0831-6, PMID 31421677.
32. Earle R, Shanahan E, Vaghadia H, Sawka A, Tang R. Epistaxis during nasotracheal intubation: a randomized trial of the parker flex-tip™ nasal endotracheal tube with a posterior facing bevel versus a standard nasal RAE endotracheal tube. Can J Anaesth. 2017;64(4):370-5. doi: 10.1007/s12630-017-0813-4, PMID 28078544.
33. Smith JE, Grewal MS. Cardiovascular effects of nasotracheal intubation. Anaesthesia. 1991;46(8):683-6. doi: 10.1111/j.1365-2044.1991.tb09724.x, PMID 1887981.
34. Yoon JY, Park CG, Kim EJ, Choi BM, Yoon JU, Kim YH. Optimal effect-site concentration of remifentanil to prevent hemodynamic changes during nasotracheal intubation using a video laryngoscope. J Dent Anesth Pain Med. 2020;20(4):195-202. doi: 10.17245/jdapm.2020.20.4.195, PMID 32934985.
35. Singh S, Smith JE. Cardiovascular changes after the three stages of nasotracheal intubation. Br J Anaesth. 2003;91(5):667-71. doi: 10.1093/bja/aeg240, PMID 14570788.
36. Tong JL, Smith JE. Cardiovascular changes following insertion of oropharyngeal and nasopharyngeal airways. Br J Anaesth. 2004;93(3):339-42. doi: 10.1093/bja/aeh207, PMID 15220172.