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North Polar Tube Reduces the Risk of Epistaxis during Nasotracheal Intubation: A prospective, Randomized Clinical Trial ☆,☆☆

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ABSTRACT

Objective: In this study, a north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]) (NPT) and spiral tube (ST) were compared for their ability to provide a nasal airway in patients during maxillofacial surgery.
Methods: Patients who were aged 18 to 65 years with American Society of Anaesthesiologists score 1 to 2 and Mallampati score 1 to 2 were included in the study. The anesthesia technique was standardized in all patients. Patients were divided into 2 groups randomly: the NPT (n = 35) and ST groups (n = 35). Anesthesia was administered with 1% to 2% sevoflurane and a mixture of 50% oxygen + 50% air in both groups. The mean arterial pressure and heart rate values of preinduction; preintubation; and the first, second, third, and fifth minutes of intubation were recorded. Epistaxis, intraoral bleeding, cuff burst, use of Magill pens, duration of intubation, intubation difficulty, laryngeal compression, head position change, and glottic grade were evaluated.
Results: There were no significant differences between groups in terms of demographic data (gender, age, height, weight, body mass index, American Society of Anaesthesiologists score, and Mallampati score). Macintosh laryngoscopes were used during intubation in all patients. There was no significant difference between groups in terms of intubation difficulty, duration of intubation, use of Magill pens, and determination of the glottic grade ($P > 0.05$). Epistaxis was significantly lower in the NPT group than in the ST group ($P = 0.012$). Intraoral bleeding was significantly higher in the ST group than in the NPT group ($P = 0.001$). During intubation, laryngeal compression (Sellick maneuver) and head position changes were significantly lower in the NPT group than in the ST group ($P = 0.003$ and $P < 0.001$, respectively). There were no significant differences in mean arterial pressure and heart rate between the 2 groups.
Conclusions: We conclude that the NPT was associated with less epistaxis and manipulations such as laryngeal compression and head position changes when compared with the ST during nasotracheal intubation. The velvet-soft polyvinyl chloride material of the NPT appears to be responsible for this advantage.

Introduction

Airway management during maxillofacial surgery is often performed via a nasal approach. Nasotracheal intubation (NTI) is often preferred to avoid aspiration of blood to the lungs and to provide good vision in oral, dental, or maxillofacial surgery.[1,2] Many different types of intubation tubes are used in NTI, and studies have described a variety of preferences regarding the choice of tube. The structure, shape, softness, and flexibility of the intubation tube are related to the application success and reduced complication rates. Various factors, such as tube lubrication, use of topical vasoconstrictors, tube heating, and different design of tube tips, have been used to reduce complications.[3–6] Standard nasotracheal tubes (NTTs) are designed to be 45° inclined and convex to prevent distal trauma. In these procedures, the tube can be oriented toward the entrance of the trachea in accordance with the inclination of the nasopharynx and posterior pharyngeal wall.[4]

The Portex North Polar tube* (NPT) has been produced for maxillofacial surgery as a supplement to NTI tubes that are frequently used worldwide. The Portex NPT is made from velvet-soft polyvinyl chloride (PVC) material and for this reason, may reduce the risk of trauma. This design of this tube enables it to access the face during surgery, allowing the surgeon to observe the effect of maxilla manipulation on facial symmetry.

The difficulty rate was reported to be 37% to 71% during NTI.[7] Various complications, such as epistaxis and nasopharyngeal airway injury, may develop during NTI.[8] However, the most common complications are epistaxis and mucosal injury. Patients with anatomic abnormalities of the nasal pathway have been shown to have an increased risk of developing epistaxis.[9] This study was performed based on the hypothesis that the Portex NPT, which has a soft structure, will reduce the risk of complications such as epistaxis after examining previous studies.[10,11] In this study, the Portex NPT and spiral tube (ST) were compared for their ability to provide a nasal airway passage in patients during maxillofacial surgery.

Materials and Methods

The study protocol was approved by the Local Clinical Ethics Committee (No. 2017/95), and informed consent was obtained from all patients.

Patient population

Seventy patients who underwent maxillofacial surgery with NTI between January 2017 and August 2017 were included in the study. The patients were aged 18 to 65 years, American Society of Anaesthesiologists (ASA) score 1 to 2 and Mallampati (MP) score 1 to 2.

Exclusion criteria

Patients with glaucoma, diabetes mellitus, cardiovascular and pulmonary disease, ASA score 3 to 4, MP score 3 to 4, obstructive neck surgery, body mass index (BMI) >35, difficult airway, anticoagulation therapy, fentanyl use, and rocuronium contraindications were excluded from the study. Patients with predicted difficult airway (eg, restricted mouth opening, limited neck extension, pharyngeal pathology, those at risk of regurgitation, those with airway obstruction at or below the level of the larynx, or thyromental distance <6 cm) were excluded. Patients who were intubated longer than 60 seconds were excluded from the study.

Grouping of patients

Patients were allocated prospectively and randomly to the Portex NPT group (n = 35) and ST group (n = 35) using an online research randomizer (http://www.randomizer.org/form.htm). During NTI, Macintosh laryngoscope (blade size 3) was used in all patients. A patent nostril was identified by an otorhinolaryngologist preoperatively, and NTI was performed through this nostril. If there was no difference in nostrils, NTI was performed through the right nostril.[2]

Anesthesia procedure

During preoperative visits, all patients were assessed by an anesthesiologist for difficulty in laryngoscopy or visualization of the glottis by MP grading, measuring thyromental distance and extension at the atlanto-occipital joint. All patients fasted at least 8 hours before surgery and were restricted from oral intake of clear fluid for 2 to 3 hours. The anesthesia technique was standardized in all patients. No premedication was administered. Intravenous cannula was performed and thereafter Ringer's lactate

infusion at the rate of 15 mL/kg/h was started through an infusion pump. The patients were connected to an echocardiogram machine, noninvasive blood pressure (ie, systolic and diastolic blood pressure and mean arterial pressure [MAP]) measurement device, peripheral pulse oximeter, capnography machine, and train-of-4 neuromuscular monitor using a Datex-Ohmeda S/5 Anaesthesia Monitor (Datex-Ohmeda Instrumentarium Corp, Helsinki, Finland). To assess the depth of anesthesia, which was kept between 40 and 60, a Bispectral Index Monitor Model 2000 (Aspect Medical Systems Inc, Newton, Massachusetts) was used. After providing venous access, 0.1% xylometazoline hydrochloride was applied to both nostrils, and preoxygenation with 100% oxygen for 5 minutes was performed. After preoxygenation, anesthesia was induced with 2 mg/kg propofol and 1 µg/kg fentanyl intravenously over 15 to 20 seconds. When any response to verbal command was lost, patients were ventilated via a facemask with 100% oxygen and NTI was started after complete suppression (ie, 0) of the train-of-4 as guided by the neuromuscular monitor. Muscle relaxation was achieved with 0.6 mg/kg rocuronium. All NTIs were performed by same experienced anesthetists (ie, >100 successful NTIs). Tubes with an internal diameter of 6.5 mm for men and 6.0 mm for women were used. Each tube was lubricated with a water-soluble gel before intubation, and no other method of softening the tubes was performed. After successful intubation, the cuff of the NTT was inflated with air to a pressure of 15 cm H_2O and controlled using a handheld aneroid manometer. The proper placement of NTT was confirmed by capnography tracing. After tracheal intubation was successfully accomplished, the tracheal tube was connected to the anesthesia breathing system for intermittent positive pressure ventilation. Anesthesia was maintained with 1% sevoflurane and 50% oxygen-air mixture. During the observation, a fresh gas flow of 1.5 L/min was used and the ventilatory parameters were, tidal volume 8 to 10 mL/kg and respiratory rate (8 to 12 breaths/min) adjusted to keep end tidal carbon dioxide level between 30 and 35 mm Hg. At the end of surgery, the residual neuromuscular blockade was antagonized with neostigmine and atropine in appropriate dosages.

Intubation was performed in 3 phases: the intubation tube was blindly placed in the patent nostril so that the tip of the tube reached the oropharynx; direct laryngoscopy was performed by applying the neck extension; and with or without the help of Magill pens, the tube was directed to the entrance of the trachea and intubation was performed by advancing the tube.

Epistaxis was assessed 5 minutes after intubation by another anesthetist who was blinded to the intubation method, and bleeding was measured by pharyngeal aspiration with a 14F, 50-cm suction catheter; 2.5-m suction tube; and –100 mm Hg pressure.[12] The grade of epistaxis was assessed according to the aspirated blood length as follows: none = no bleeding, minimal = between 0 and 50 cm bleeding, medium = between 50 and 300 cm bleeding, and severe = >300 cm bleeding. Intraoral bleeding was evaluated according to the presence of blood below the entrance of the trachea during direct laryngoscopy after nasal administration of the tube. Intraoral bleeding was classified as follows: none = no bleeding, mild = blood spot at the head of the tube, and severe = blood pooling in the posterior pharyngeal wall.[13] Intubation difficulty was rated on a scale of 0 to 100.

Laryngeal compression (ie, Sellick maneuver) was defined as externally applied pressure to facilitate the entry of the end of the tube into the trachea. The head position change was defined as a slightly left or right change in head position (up to 15°) during the orientation of the end of the tube. The duration of the intubation was recorded as the time from the handling of the intubation tube to the appearance of 3 smooth end-tidal carbon dioxide waves. The glottic grade was determined according to the Cormack-Lehane score.

Table 1
Demographic data.*

Characteristic	NPT (n = 35)	ST (n = 35)	P value
Gender			0.811
Male	17 (48.6)	18 (51.4)	
Female	18 (51.4)	17 (48.6)	
Age, y	24.3 (7.7)	26.8 (9.1)	0.230
Height, cm	165.3 (9.1)	166.7 (9.6)	0.544
Weight, kg	64 (13.1)	65.9 (10.5)	0.497
BMI	23.1 (3.9)	21.9 (2.9)	0.148
ASA score			0.115
1	17 (48.6)	22 (62.9)	
2	18 (51.4)	11 (31.4)	
MPS			0.586
1	20 (51.7)	18 (51.4)	
2	15 (42.9)	17 (48.6)	

ASA = American Society of Anaesthesiologists; BMI = body mass index; MPS = Mallampati score; NPT = north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]); ST = spiral tube.

* Values for gender, ASA score, and MPS are presented as n (%). Other values are presented as mean (SD).

Table 2
Intubation characteristics.*

Characteristic	NPT (n = 35)	ST (n = 35)	P value
Intubation difficulty[†]	31.7 (18.2)	30.8 (15.7)	0.834
Duration of intubation, sec	25.9 (31.3)	32.2 (15.7)	0.348
Epistaxis	1 (2.9%)	8 (22.9%)	0.012[‡]
Minimal	1	4	
Medium	0	3	
Severe	0	1	
Intraoral bleeding	0 (0%)	9 (25.7%)	0.001[‡]
Mild	0	8	
Severe	0	1	
Use of Magill pens	2 (5.7)	7 (20)	0.074
Laryngeal compression	4 (11.4)	15 (42.9)	0.003[‡]
Head position change	1 (2.9)	16 (45.7)	< 0.001[‡]
Glottik grade			0.601
1	28 (80)	29 (82)	
2	6 (17.1)	6 (17.1)	
3	1 (2.9)	0 (0)	

NPT = north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]); ST = spiral tube.

* Values for intubation difficulty and duration of intubation are presented as mean (SD). Other values are presented as n (%).

[†] Rated on a scale of 1 to 100.

[‡] Compared with each other (P < 0.05).

The MAP and heart rate values of preinduction; preintubation; and the first, second, third, and fifth minutes of intubation were recorded. Epistaxis, intraoral bleeding, cuff burst, Magill pens use, duration of application, intubation difficulty, laryngeal compression, head position change, and glottic grade were evaluated.

Statistical Analysis

Data were analyzed using SPSS version 22.0 for Windows (IBM-SPSS Inc, Armonk, New York). Age, BMI, weight, height, and severity of epistaxis were tested using the Mann-Whitney U test, and gender, ASA score, and intubation characteristics were compared using Fisher exact test. A normal distribution was performed using the Shapiro-Wilk test. The χ^2 test, Student t test, and Pearson and Shearman correlation analysis were performed. A P value < 0.05 was considered significant in all evaluations.

Results

There were no significant differences between groups in terms of demographic data (ie, gender, age, height, weight, BMI, ASA score, and MP score) (Table 1). All intubations were applied by same anesthesiologist with Macintosh direct laryngoscope. The intubation characteristics are shown in Table 2. There was no significant difference between groups in terms of intubation difficulty, duration of intubation, and Magill pens use during the procedure and determination of the glottic grade (P > 0.05). Epistaxis was significantly lower in the NPT group than in the ST group (P = .012) (Table 2). Intraoral bleeding was significantly higher in the ST group than in the NPT group (P = 0.001) (Table 2). During intubation, laryngeal compression (ie, Sellick maneuver) and head position changes were significantly lower in the NPT group than in the ST group (P = 0.003 and P < 0.001, respectively) (Table 2). MAP and heart rate were not significantly different between the 2 groups (Figures 1 and 2).

Discussion

The main results of our study were that epistaxis, laryngeal compression, and head position change frequency were lower in NTI using the Portex NPT, which has a softer structure than the spiral tube (Figure 3).

Many tube types are used in NTI applications. Tubes for nasal airway management are preferred more often than oral tubes because of their length. Nasal tubes differ according to their composition and design. PVC, rubber, polyurethane, and silicone are the most commonly preferred types of tubes. There are 2 types nasal tubes, the Murphy type and Magill type, according to the design of the tube tips. It is also important for the nasal tubes to be coated with a material to make them softer.[14,15] Coating the tubes with a soft material is an effective way to reduce trauma and complications, such as epistaxis.[16] To reduce complications in NTI applications, a shaped, reinforced, or softened tube has been developed. The silicone-made, wire-reinforced tubing is designed to reduce nasal trauma, and it was shown that these tubes require fewer interventions than tubes made of PVC.[8] We preferred to use the Portex NPT made from a velvet-soft PVC material because it reduce the risk of trauma. Although the cost of the Portex NPT is higher than that of STs, its usage rate is increasing due to its possible benefits.

There are 2 pathways in the nasal cavity: the lower and upper pathways. The lower pathway is more secure and preferred to the nose floor. The upper pathway is between the inferior and middle turbinates. Ahmed Nusrath et al[4] reported that the use of a subpathway (under the inferior turbinate) in NTI would reduce complications such as hemorrhage by blocking trauma in the middle turbinate. Those authors also reported that intubation from the upper pathway is proportional to an increased bleeding risk.[4] However, if the intubation tube is blindly advanced, it cannot be guaranteed that the tube will advance from the lower pathway, leading to an increase in the bleeding rate. The superior turbinate is the smallest of the turbinates, and if blind NTI is performed there, the risk of nasal trauma would increase. The inferior turbinate is the largest turbinate and extends along the lateral nasal wall. The central turbinate is centrally located near the nasal septum.[17] The softness of the tip of the tube will reduce trauma in the nasopharynx and oropharyngeal wall. However, it has been claimed that trauma is reduced when the tube is softened by heating.[18] In addition, it is difficult to pass through the nasal cavity due to collapse.[2] It has been reported that heating the intubation tube is difficult to use as a standard procedure because it is a difficult procedure to perform and can make the shape of the tube deformable. Heating the tube during videolaryngoscope-assisted NTI was reported to not be beneficial.[2] Additionally, it was reported that the temperature of the liquid heating of the tube may need to be controlled, resulting in an obstruction or distortion due to overheating.[19] In our study, we preferred to use the Portex NPT
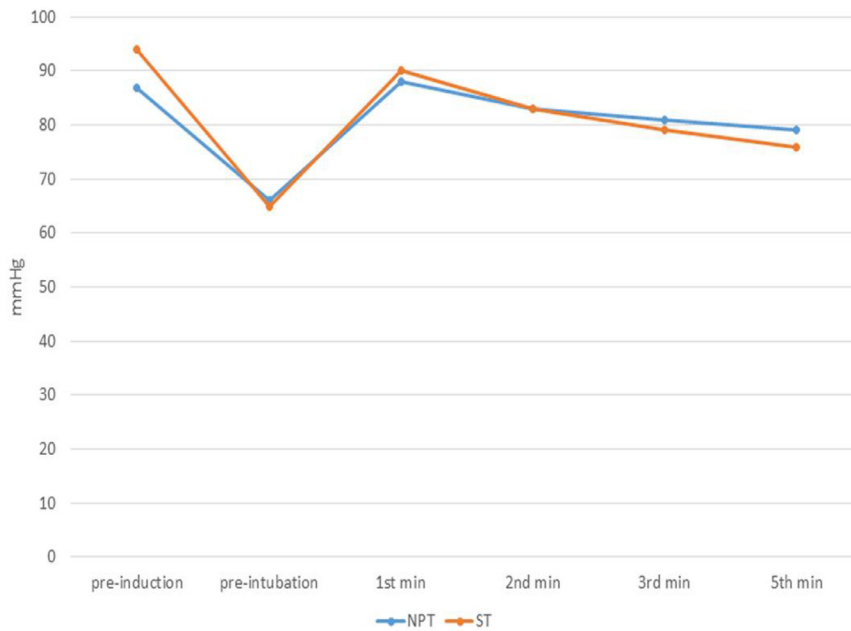
Figure 1. Mean arterial pressure (MAP). No significant difference was found between the north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]) (NPT) and spiral tube (ST) groups ($P > 0.05$).
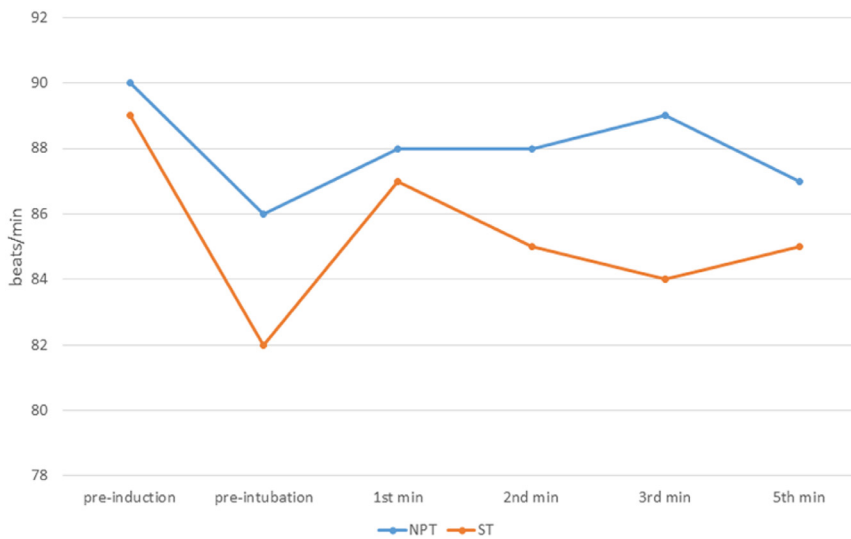
Figure 2. Heart rate (HR). No significant difference was found between the north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]) (NPT) and spiral tube (ST) groups ($P > 0.05$).

because of its soft and flexible structure and design. The structure of STs is rigid compared with the Portex NPT. We showed that the risk of epistaxis was decreased during NTI using the Portex NPT.

NTI is frequently used in patients undergoing dental and maxillofacial surgery to control the airway, control ventilation, and effectively apply anesthetic gases. Several causes related to epistaxis due to intubation during and after NTI have been reported. Epistaxis during NTI is an important complication, and serious epistaxis cases have been reported.[20,21] During the preanesthetic evaluation, conditions such as risk factors for nasal intubation should be assessed and a determination of the presence of contraindications to nasal intubation should be made in advance. Intranasal abnormalities are seen in two-thirds of patients who have undergone oral surgery.[22] More unilateral abnormalities, such as concha bullosa, septal deviation, and nasal polyps, usually

affect the development of complications in NTI.[4] It has been suggested that intubation should be performed with caution and softness, especially in patients with systemic hemorrhagic disease. Therefore, the preoperative evaluation of patients should be assessed in terms of hemorrhagic diseases. Although Kihara et al[8] and Seo et al[12] reported that the method that minimizes the incidence of epistaxis during NTI is to heat the tube, epistaxis is still observed in between 40% and 68% of cases.[20] Thus, it is believed that the structure of tube, in addition to heating the tube, may reduce the risk of complications. Various complications, such as retropharyngeal perforation, traumatic tissue injury, lacerations in nasal and pharyngeal tissues, glottic edema, tracheal stenosis, vocal cord paralysis, and arytenoid cartilage dislocation due to NTI have also been reported in case reports.[23–27]

Depending on the location of the surgeon or anesthetic device, NTI recognizes the selection of the nostril and is usually performed

Figure 3. The north polar tube (Portex® North Polar tube [Ivory PVC Portex tube; Smiths Medical International, Hythe, United Kingdom]) (*top*) and spiral tube (*bottom*).

without a nasal puncture evaluation. Some studies have claimed that the choice of the left nostril by orthognathic surgeons is more beneficial.[28] Chi et al[29] showed no significant relationship between the choice of the right or left nasal passage and incidence of complications in NTI. Some studies have suggested that the selection of the left nostril during NTI increases the complication rates.[30] In some studies, it was reported that the complication rates were reduced when the right nostril was selected.[15] The commonly used method of selecting a patent nostril is to close a nostril and evaluate the ease of breathing with the other nostril. However, among the most effective methods for selecting a patent nasal route is the application of anterior rhinoscopy.[22] Nasal endoscopy is also a preferred method. In our study, patients were assessed via endoscope preoperatively by an otorhinolaryngologist and the right nostril was preferred if it was the most patent nostril or if both sides were the same.

During NTI, it may be necessary to use Magill pens, neck movements, or pressure on the trachea for the tip of the tube to be directed toward the entrance of the trachea. NTI, with the help of a fiberoptic bronchoscope, is a preferred method because it does not cause pharyngeal or nasal trauma and there is no need for an additional route to the tube.[31] However, fiberoptic bronchoscopy is a practice that requires experience, and at many institutions only some anesthetists are experienced in this technique. Thus, studies are underway to reduce the trauma of classic NTI, in which the tube is advanced blindly to reduce trauma. In our study, we aimed to investigate different methods and tube types to reduce the risk of epistaxis and facilitate NTI.

Limitations

Our study had some limitations. First, our study was performed in a small group of patients and all our results may not be generalizable to other races and countries because this study population was mainly Turkish people. Second, different outcomes may be found in patients with anticipated difficult airway. Third, nasal mucous membranes sensitivity due to pre-existing upper respiratory infections of patients could not be assessed.

Conclusions

The Portex NPT was associated with less epistaxis and manipulations such as laryngeal compression and head position changes when compared with the ST during NTI. The velvet-soft PVC material of the NPT appears to be responsible for this advantage. Further studies are needed in terms of NTI in children.

Acknowledgments

Conflicts of Interest

The authors have indicated that they have no conflicts of interest regarding the content of this article.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.curtheres.2018.09.002.

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