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Research Article

Effect of Nasotracheal Tube Bevel Orientation on Epistaxis, Intubation Difficulty, and Intraoperative Complications

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ABSTRACT

Background: Nasal bleeding is a common event during nasotracheal intubation. The present trial examined whether altering bevel orientation (upward, downward, right, or left) affects the likelihood of epistaxis, ease of intubation, and intraoperative outcomes.

Methods: In this triple-blind randomized controlled trial, 200 candidates for elective oral and maxillofacial procedures were randomized into four groups based on bevel orientation. The principal endpoint was the frequency and severity of epistaxis. Secondary endpoints included intubation time, difficulty score, hemodynamic responses, and oxygen saturation. Data were evaluated using chi-square, ANOVA, and Kruskal–Wallis tests ($p<0.05$).

Results: The incidence and grading of epistaxis, intubation time, and difficulty did not significantly differ between the four orientations. Hemodynamic and oxygenation parameters remained stable throughout. Lateral orientations showed a non-significant tendency toward less bleeding and smoother tube passage.

Conclusion: Bevel direction did not significantly influence bleeding or difficulty of nasotracheal intubation, although subtle clinical advantages were observed. Larger trials are needed to clarify the potential benefits.

Introduction

Airway management is a cornerstone of anesthetic practice, and failure to secure the airway remains a major contributor to anesthesia-related morbidity and mortality [1-2]. Direct laryngoscopy has long been the standard approach for tracheal intubation, yet visualization may be restricted by anatomical factors such as limited mouth opening, prominent incisors, a short or thick neck, or an anteriorly positioned larynx. Anticipating these challenges and employing alternative techniques are essential for safe practice.

Over the past two decades, devices such as video laryngoscopes and flexible fiberoptic scopes have significantly improved airway management. Large clinical trials and systematic reviews demonstrate that video laryngoscopes enhance glottic visualization and increase the likelihood of first-pass success, particularly in patients with predictors of difficult airways [3-4]. Fiberoptic intubation remains the reference technique for anticipated difficult intubations and continues to be invaluable in awake patients [5].

Nasotracheal intubation (NTI) is frequently required in oral and maxillofacial surgery because it provides unobstructed access to the surgical field. However, NTI is associated with complications such as nasal trauma, bleeding, and resistance at the glottic inlet. Among the modifiable technical factors, the orientation of the tube bevel has attracted attention. Adjustments toward cephalad, caudal, posterior, or lateral orientations may alter the ease of passage, the risk of mucosal injury, and postoperative complications. Several clinical studies

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have explored these orientations, showing potential benefits in reducing trauma and improving intubation success [6–9].

Therefore, the present study was undertaken to evaluate the effect of bevel orientation during NTI on epistaxis, intubation difficulty, and perioperative complications. We hypothesized that bevel orientation, as a simple and cost-free maneuver, could improve both the safety and success of nasotracheal intubation.

Methods

The present study was approved by the Ethics Committee (IR.MUI.MED.REC.1403.088) of the University, and informed consent was obtained from the patients, or the legal guardians were obtained. The study was listed at www.irct.ir with a documentation code of IRCT (IRCT20160307026950N61). The trial was performed following the principles of the Helsinki Declaration and adhered to CONSORT guidelines.

Study design and participants

This was a prospective, triple-blind, randomized controlled trial conducted at two university-affiliated teaching hospitals. A total of 200 adult patients scheduled for elective oral and maxillofacial surgery were enrolled. Eligibility criteria included ASA physical status I–II. Patients with a history of recurrent epistaxis, coagulopathy, uncontrolled hypertension, ischemic heart disease, or nasal septal deviation were excluded.

Randomization and blinding

Participants were randomly assigned in equal numbers to one of four groups according to endotracheal tube bevel orientation (upward, downward, right, or left). Randomization was performed using a computer-generated sequence and sealed opaque envelopes. The study was conducted under triple-blind conditions: patients, anesthesiologists performing intubation, and outcome assessors were blinded to group allocation.

Interventions

All patients received standardized anesthetic induction with intravenous lidocaine, fentanyl, propofol, and atracurium. Phenylephrine-soaked swabs were inserted into both nostrils for mucosal decongestion, and all nasotracheal tubes were thermosoftened in warm saline before intubation. Intubation was performed according to group allocation.

Outcomes

The primary outcome was the incidence and severity of epistaxis during nasotracheal intubation. Secondary outcomes included intubation difficulty (graded by the anesthesiologist), intubation time, intraoperative hemodynamic changes, and oxygen saturation.

Sample size

A total of 200 patients were recruited. (If a formal sample size calculation was performed, details should be provided here in accordance with CONSORT recommendations.)

Statistical analysis

All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were analyzed using the chi-square test. Continuous variables were assessed using one-way ANOVA or Kruskal–Wallis tests, as appropriate. A P value <0.05 was considered statistically significant.

Results

This study was conducted on 200 candidates for elective oral and maxillofacial surgery. The patients were divided into three groups (n=50 per group). Baseline variables were comparable among groups, confirming adequate randomization (Figure 1).

In (Table 1), no significant differences were identified for sex, age, weight, or height. This balance reduces the risk of confounding.

The primary endpoint—epistaxis incidence and severity—did not differ significantly across groups. While right and left bevels tended to show reduced bleeding rates, these did not reach significance ($p>0.05$). Most bleeding events were mild (grade 1–2), with only occasional moderate or severe cases.

Secondary measures also showed minimal variation. Intubation times were consistent across groups, with most cases categorized as easy or moderately difficult. Difficult intubations were uncommon. Hemodynamic measures and oxygen saturation remained stable throughout intubation (Table 2,3), indicating that bevel orientation had a negligible impact on physiological stability.

Table 1- Demographic characteristics

Variable	Upward (n=50)	Downward (n=50)	Right (n=50)	Left (n=50)	P value
Age (years)	32.40 ± 17.93	30.08 ± 15.63	26.68 ± 14.17	33.86 ± 14.27	0.059
Female (%)	23 (46%)	18 (36%)	23 (46%)	24 (48%)	0.618
Male (%)	27 (54%)	32 (64%)	27 (54%)	26 (52%)	0.618
Weight (kg)	69.86 ± 15.52	71.08 ± 17.23	65.24 ± 16.26	74.48 ± 23.45	0.370
Height (cm)	173.66 ± 7.74	172.3 ± 14.68	176.44 ± 11.34	174.52 ± 12.67	0.160

Table 2- Intubation variables and complications

Variable	Upward (n=50)	Downward (n=50)	Right (n=50)	Left (n=50)	P value
Intubation time (sec)	62.42 ± 8.31	66.16 ± 15.86	61.34 ± 12.83	62.32 ± 15.45	0.373
Epistaxis – Yes	18 (36%)	22 (44%)	17 (34%)	23 (46%)	0.539
Epistaxis – No	32 (64%)	28 (56%)	33 (66%)	27 (54%)	0.539
Severity Grade 1	10 (20%)	11 (22%)	4 (8%)	12 (24%)	0.427
Severity Grade 2	5 (10%)	7 (14%)	4 (8%)	3 (6%)	0.427
Severity Grade 3	3 (6%)	4 (8%)	7 (14%)	5 (10%)	0.427
Severity Grade 4	0 (0%)	1 (2%)	2 (4%)	3 (6%)	0.427
Intubation difficulty – Easy	29 (58%)	35 (70%)	41 (82%)	39 (78%)	0.062
Intubation difficulty – Moderate	11 (22%)	8 (16%)	7 (14%)	3 (6%)	0.062
Intubation difficulty – Difficult	10 (20%)	7 (14%)	2 (4%)	8 (16%)	0.062

Table 3- Hemodynamic variables and oxygen saturation

Variable	Upward (n=50)	Downward (n=50)	Right (n=50)	Left (n=50)	P value
HR before intubation	89.92 ± 17.96	86.70 ± 18.75	86.08 ± 13.68	90.92 ± 15.06	0.433
HR at 9 min	86.86 ± 18.60	85.08 ± 15.49	79.92 ± 16.80	89.26 ± 14.01	0.055
SBP before intubation	129.16 ± 13.81	127.72 ± 15.05	132.08 ± 12.09	134.70 ± 20.28	0.151
DBP before intubation	63.04 ± 22.49	102.94 ± 139.49	70.20 ± 20.66	70.50 ± 24.20	0.373
SpO_2 before intubation	99.76 ± 0.52	99.82 ± 0.44	99.78 ± 0.51	99.78 ± 0.46	0.947

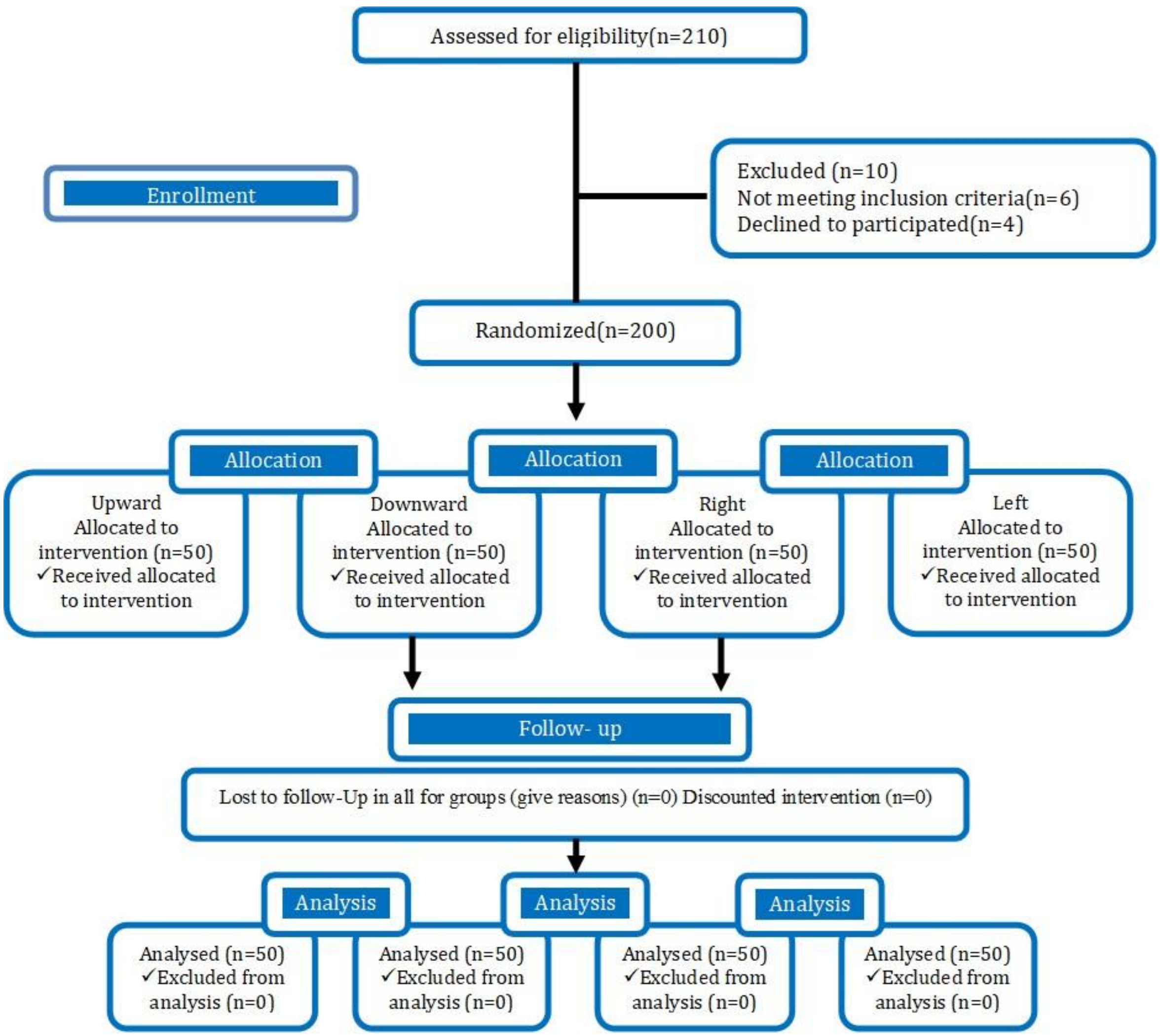

Figure 1- Flow of participants through each stage of the randomized controlled trial.

Discussion

Our study evaluated the effect of bevel orientation during nasotracheal intubation (NTI) on the incidence of epistaxis, intubation difficulty, and perioperative complications. The main findings showed that although differences among bevel orientations did not reach statistical significance, trends toward reduced bleeding and improved ease of insertion were observed with cephalad and downward orientations. These observations are best understood in the context of previous literature.

Several clinical trials have examined the influence of bevel orientation. Won et al. [8] demonstrated that cephalad bevel orientation facilitated passage through the lower nasal passage and reduced epistaxis. Park et al. [9] similarly found that reversing bevel orientation during left-sided intubation reduced bleeding and improved comfort. Our results echo these findings, although smaller sample size and effect size likely contributed to non-significant differences. Sugiyama et al. [10] tested a special modification of tube design and bevel direction. Their findings highlight that subtle adjustments in tube orientation can alter trauma risk during NTI.

Other investigations confirmed that thermosoftening of the tube improves navigability and reduces trauma. Kim YC et al. [11] reported that pre-warming endotracheal tubes decreased nasal mucosal injury, while Kim EM et al. [7] demonstrated benefits when using thermosoftening under videolaryngoscopic guidance. Our study also included thermosoftening and showed no prolongation of intubation time, consistent with these reports. Prashant et al. [12] and Özkan et al. [13] explored additional modifications. In terms of epidemiology, Abdi et al. [5] identified patient- and surgery-related predictors of epistaxis during NTI, while Farhadi et al. [6] evaluated nasal complications prospectively and emphasized the influence of anatomical variation and tube characteristics. Together, these studies suggest that both patient selection and operator technique contribute significantly to outcomes. Our data similarly show that baseline variables, such as ASA class and intubation time, did not differ substantially across complication rates. Meta-analyses and systematic reviews have synthesized this growing body of evidence. Tan et al. [14] concluded that the right nostril is generally associated with fewer bleeding events and faster intubation than the left. Tong and Tung [15] also showed advantages of fiber optic guidance compared with blind or direct techniques. Lewis et al. [16] and Aziz et al. [17] demonstrated the superiority of videolaryngoscopy over direct laryngoscopy in difficult airway scenarios, while Frerk [18] and expert guidelines and expert recommendations further support these practices. Apfelbaum et al. [19], in the American Society of Anesthesiologists' updated guidelines, emphasized preparedness and flexibility in difficult airway management. Cook and MacDougall-Davis [20] reviewed complications and failures in airway management, stressing the importance of prevention and rapid adaptation. In this framework, optimizing bevel orientation during NTI can be considered one of several low-cost, practical strategies to red uced bleeding and enhance patient safety.

Finally, the broader clinical implications must be considered. Our trial adds to the literature by confirming that bevel orientation does not increase intubation time or compromise hemodynamic stability, supporting its practicality. Moreover, emerging evidence such as Kim et al. [21] showed that bevel orientation may even reduce postoperative sore throat, broadening the scope of its relevance. Choudhry et al. [22] demonstrated benefits of a counterclockwise bevel adjustment in pediatric NTI, highlighting that these manipulations are not limited to adults. Collectively, the evidence suggests that individualized bevel orientation, chosen in conjunction with nostril selection, thermosoftening, and appropriate tube design, provides tangible, though sometimes subtle, improvements in patient comfort and safety.

Conclusion

In conclusion, our findings, integrated with existing evidence, suggest that bevel orientation remains a simple, modifiable factor in NTI. While not always statistically significant in isolated trials, when combined with patient selection, device choice, and adjunctive techniques, bevel orientation offers clinically meaningful benefits. Larger multicenter randomized controlled trials are warranted to establish definitive guidance, but current evidence supports tailoring bevel direction as part of a management strategy for anesthesia of oral and maxillofacial surgery.

Ethical Statement

The trial was approved by the Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.MED.REC.1403.088) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

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