The Influence of Endotracheal Tube Tip Design on Nasal Trauma During Nasotracheal Intubation: Magill-Tip Versus Murphy-Tip

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We performed this study to assess the influence of endotracheal tube (ETT) tip design (Murphy-tip versus Magill-tip) on nasal trauma during nasotracheal intubation with a conventional polyvinyl chloride ETT. Patients were randomly allocated to one of four groups (n = 25 each): Magill-tipped ETT and Murphy-tipped ETT with or without thermosoftening. After preparation with a vasoconstrictor, the selected, well-lubricated ETT was advanced blindly into the nasopharynx, and intubation was completed under direct laryngoscopy. The severity of epistaxis was estimated based on the distance that blood had traveled up the suction catheter and tubing. Without thermosoftening, the Murphy-tipped ETT produced more severe epistaxis than the Magill-tipped ETT (P < 0.05). Thermosoftening effectively reduced the severity of epistaxis for both conventional types of ETT (P < 0.05). However, there was no difference in the severity of epistaxis and the incidence of nasal injury and pain between the Magill-tipped, nonthermosoftened ETT and Murphy-tipped, thermosoftened ETT. Thermosoftening is recommended because it decreases the trauma during nasotracheal intubation. However, if one chooses to use a normal ETT, the Magill-tipped ETT will cause fewer traumas than the Murphy-tipped ETT.

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Some surgical procedures involving the head and neck may require nasotracheal intubation, which is inherently more traumatic than orotracheal intubation. Although the incidence of complications after nasotracheal intubation is reported to be variable, the most common complication associated with nasotracheal intubation is epistaxis (1–4). The amount of epistaxis is not usually a problem for the patient or the surgical procedure, but even life-threatening bleeding has been occasionally reported (5).

Lubrication, use of a vasoconstrictor, and prewarming of endotracheal tubes (ETT) for softening have been recommended to reduce trauma during nasotracheal intubation (6–8). Also, some mechanical techniques such as obturating or wrapping the ETT tip with soft materials (9–11) and using an ETT with a soft hemispherical bevel were effective for less traumatic passage of the nasotracheal ETT (12). All of these reports seem to show the importance of ETT tip design on nasal mucosal trauma during nasotracheal intubation.

The two most common ETT types made of polyvinyl chloride (PVC) (a conventional ETT with a Murphy eye [Murphy tip] versus a conventional ETT without a Murphy eye [Magill tip]; Fig. 1) have never been studied regarding nasal mucosal trauma. This prospective study was performed to assess the influence of the conventional ETT tip designs on nasal mucosal trauma during nasotracheal intubation depending on whether the PVC ETT is thermosoftened.

Methods

After obtaining IRB approval and informed consent from each patient, 100 patients, ASA physical status I or II, and older than 16 yr, were enrolled. All patients were scheduled for elective surgeries in which nasotracheal intubation was indicated to optimize the surgical approach. Patients were excluded if they had a documented history of difficult intubation, a potentially difficult airway suggested in physical examination, a
history of obstructive sleep apnea, nasal surgery, nasal trauma, recurrent epistaxis, and bleeding diathesis, and a history of taking anticoagulant drugs, or risks for aspiration.

At the preanesthetic interview, all the patients were questioned as to which nostril was easier to breathe through. An otolaryngologist, who was unaware of the exact study design and purposes, preoperatively evaluated the nasal anatomy, including septal deviation, turbinate hypertrophy, and mucosal abnormality such as nasal polyps by using a rhinoscope. The nostril to be intubated was determined on the basis of the preanesthetic information and the otolaryngologic examination: the nostril on the side of easier breathing and wider-looking without mucosal abnormality was selected. The right nostril was chosen for intubation if all the evaluated and questioned conditions were the same.

Based on the ETT tip design and the presence of thermosoftening, patients were randomized to one of four groups \(n = 25\) each using sealed envelopes that were opened at the induction of anesthesia: Group 1 = Magill-tipped ETT without thermosoftening; Group 2 = Magill-tipped ETT with thermosoftening; Group 3 = Murphy-tipped ETT without thermosoftening; and Group 4 = Murphy-tipped ETT with thermosoftening.

Anesthetics and anesthesia techniques were standardized for all patients. After applying routine monitoring, such as electrocardiogram, pulse oximetry, and capnograph, and noninvasive arterial blood pressure, patients were placed in the supine position with the head on an approximately 7-cm-high pillow. Anesthesia was induced with thiopental 5 mg/kg and fentanyl 1–2 \(\mu g/kg\) IV. Neuromuscular blockade was obtained with vecuronium 0.1–0.15 mg/kg IV. Patients’ lungs were ventilated via a face mask with 2–3 vol\% of isoflurane in 100% oxygen. During mask ventilation, 2 cotton swabs soaked with 0.1% topical epinephrine were applied to the nasal mucosa on each side for vasoconstriction.

A 7.0-mm internal diameter (ID) ETT (Euromedical Industries, Kedah, Malaysia) was used for men and a 6.0-mm ID ETT (Euromedical Industries) for women. Two anesthesiologists (J-H L and K-S P) with more than 3 yr experience performed all intubations and were assigned the same number of intubations in each group. In all four groups, any excess air in the cuff was completely aspirated, and the ETT was withdrawn from the saline bottle and lubricated with water-soluble jelly immediately before insertion. The temperature of normal saline was adjusted to \(40^\circ C \pm 1^\circ C\) for thermosoftening and was maintained at room temperature for the nonthermosoftened group. The ETT was advanced blindly through the nose into the nasopharynx with the ETT curve facing anterior and downward. If resistance was felt, the ETT was withdrawn, and the following manipulations were applied in sequence: (a) anticlockwise rotation with gentle cephalad tilting of ETT, (b) reinsertion into the other nostril, and (c) reinsertion into the other nostril with anticlockwise rotation with gentle cephalad tilting of ETT. Intubation was completed under direct laryngoscopy. If required, Magill forceps were used at the discretion of the anesthesiologists.

The anesthesiologists who performed the intubations estimated the degree of navigability through the nasal passage, defined as smooth or impinged, and recorded the number of insertion attempts. An anesthesiologist not aware of the exact procedure estimated the number of attempts remaining outside the operation room until the ETT was positioned and then estimated the severity of epistaxis 5 min after the intubation. Epistaxis was measured by aspiration of the pharynx using a 14F, 50-cm-long suction catheter serially connected with a 7.0-mm ID, 2.5-m-long suction tube (6,12,13). The severity was graded according to the distance that blood had traveled up the suction catheter and tubing: none = no blood aspirated; slight = blood aspirated by <50 cm; moderate = blood aspirated by 50–300 cm; and severe = blood aspirated by >300 cm. After intubation, breath sounds were auscultated on the chest and confirmed to be clear, excluding the possibility of blood aspiration. In the postanesthesia care unit, all patients were checked for difficult breathing, persistent nasal bleeding, and nasal pain. The same otolaryngologist assessed the nasal damage, such as blood crust and mucosal tearing, on the first postoperative day.

On a basis of a 90% incidence of epistaxis (with normal Murphy-tipped ETTs) in the pilot study, a sample size calculation was performed to detect a 35% difference between the normal Magill-tipped ETT and

Figure 1. Murphy-tipped (left) and Magill-tipped (right) endotracheal tubes (ETT). The tip designs of ETT are different in the presence of a Murphy eye and the roundness of the distal end.
the normal Murphy-tipped ETT, with respect to the severity of epistaxis for a type I error of 0.05 and a power of 0.8. Patient characteristics, except sex, were compared with the analysis of variance test, and sex was compared with the $\chi^2$ test. The Kruskal-Wallis test was used to compare the severity of epistaxis, and the multiple comparisons among groups were analyzed by the Wilcoxon rank sums test with the Bonferroni correction. Intubation characteristics and postprocedure complications were compared by the $\chi^2$ test or Fisher’s exact test. The SPSS software (version 12.0; SPSS Inc, Chicago, IL) was used. A $P$ value <0.05 was considered statistically significant.

## Results

Patient characteristics, chosen nostrils, number of intubation attempts, navigability, and Magill forceps use were not different among the four groups (Table 1). There were no intubation failures. Epistaxis was the most severe in the Murphy-tipped group without thermosoftening and the least severe in the Magill-tipped thermosoftened group ($P < 0.001$).

Without thermosoftening, epistaxis was more severe in the Murphy-tipped group than in the Magill-tipped group ($P < 0.05$). With thermosoftening, epistaxis became less severe, regardless of the ETT tip design ($P < 0.05$ for Magill-tipped group; $P < 0.001$ for Murphy-tipped group). There were no statistical differences in the severity of epistaxis between the Magill-tipped nonthermosoftened group and the Murphy-tipped thermosoftened group (Table 2). The incidence of mucosal damage and nasal pain in the Murphy-tipped group without thermosoftening was more frequent than in all the other groups ($P < 0.05$) (Table 2).

## Discussion

During nasotracheal intubation, the Murphy-tipped ETT was more traumatic on the nasal mucosa than the Magill-tipped ETT. The main difference in tip design between Murphy-tipped and Magill-tipped ETT is the presence of a Murphy eye at the distal end of the Murphy-tipped ETT. A sharp-edged Murphy eye may traumatize the nasal mucosa during advancement.

### Table 1. Patient and Intubation Characteristics

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>Sex (M : F)</th>
<th>ASA grade (I/II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>39 ± 9</td>
<td>60 ± 7</td>
<td>158 ± 6</td>
<td>11:14</td>
<td>17/8</td>
</tr>
<tr>
<td>Group 2</td>
<td>40 ± 8</td>
<td>61 ± 11</td>
<td>160 ± 6</td>
<td>12:13</td>
<td>17/8</td>
</tr>
<tr>
<td>Group 3</td>
<td>43 ± 11</td>
<td>61 ± 9</td>
<td>158 ± 6</td>
<td>11:14</td>
<td>17/8</td>
</tr>
<tr>
<td>Group 4</td>
<td>41 ± 10</td>
<td>62 ± 12</td>
<td>156 ± 7</td>
<td>12:13</td>
<td>15/10</td>
</tr>
</tbody>
</table>

### Table 2. Severity of Epistaxis and Incidence of Nasal Complications After Nasotracheal Intubation

<table>
<thead>
<tr>
<th>Group</th>
<th>Epistaxis</th>
<th>Nasal complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>None</td>
<td>Nasal pain §</td>
</tr>
<tr>
<td>Group 2</td>
<td>Slight</td>
<td>Persistent bleeding</td>
</tr>
<tr>
<td>Group 3</td>
<td>Moderate</td>
<td>Difficult breathing</td>
</tr>
<tr>
<td>Group 4</td>
<td>Severe</td>
<td>Blood crust or mucosal tearing ¶</td>
</tr>
<tr>
<td>Group 1*</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Group 2†</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Group 3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Group 4‡</td>
<td>11</td>
<td>0</td>
</tr>
</tbody>
</table>

Values are mean ± sd or number of patients.

*Group 1 = Magill-tipped endotracheal tube (ETT) without thermosoftening; Group 2 = Magill-tipped ETT with thermosoftening; Group 3 = Murphy-tipped ETT without thermosoftening; Group 4 = Murphy-tipped ETT with thermosoftening.

## References

through the nasal cavity (10). Additionally, roundness of the distal end of the ETT seems to be different so that the shorter and blunter tip of the Magill-tipped ETT may reduce the possibility of impaction into the nasal mucosa. These facts seem to explain why nasal trauma during nasotracheal intubation is different between these two conventional ETT types.

Epistaxis was the most severe, and the incidence of postprocedure nasal damage was the most frequent in the nonthermosoftened Murphy-tipped ETT. The severity of epistaxis for the nonthermosoftened Murphy-tipped ETT was similar to previous studies (7,9,10). Thermosoftening was effective in reducing the severity of epistaxis and the incidence of mucosal damage for the two conventional types of ETTs. This result seemed to be related to the increased flexibility of the PVC tip caused by thermosoftening and was also consistent with previous studies (6,7) in that thermosoftening was effective in decreasing the risk of epistaxis.

Lubrication, topical administration of a vasoconstrictor, and thermosoftening of ETTs have been the generally accepted measures to reduce nasal and nasopharyngeal mucosal trauma during nasotracheal intubation 6–8. Additionally, some mechanical techniques have been described to facilitate atraumatic passage of nasotracheal tubes. Watanabe et al.9) reported that the incidence of epistaxis and subglottic impaction was reduced by using an intraluminal balloon, Airguide™ nasotracheal intubation system. Enk et al. (10) and Elwood et al. (11) reported that the incidence of epistaxis was reduced by using a red rubber catheter as a guide during nasotracheal intubation. Kihara et al. (12) reported that epistaxis and postoperative nasal complications were reduced with an expensive, soft- and round-tipped, silicone ETT.

Use of the Magill-tipped PVC ETT for nasotracheal intubation may have advantages over the abovementioned methods in that special equipment or preparations are not required, there is no limitation of the ETT size, and a conventional PVC ETT is inexpensive and widely available at bedside. Because a preformed ETT for nasal use (so-called RAE™ ETT used for nasotracheal intubation; Mallinckrodt Inc., Hazelwood, MO) is also made of plastic material, selection of a Magill-tipped preformed ETT would be helpful to reduce nasal trauma. A Magill-tipped PVC ETT may be used immediately after opening the sterile ETT package.

Our study has some limitations. First, though the tip design of the ETT was designated as Magill-tip or Murphy-tip, except for the presence of Murphy eye, the tip design, such as bevel angle, the shape and size of Murphy eye, and smoothness of the inner edge, may not be exactly the same depending on the manufacturers, because definite specifications are not agreed upon (14). Second, to prevent the thermosoftened ETT from becoming stiffer on cooling, there should be a limit to the time reserved for the intubation process. Fundamentally, intubation cannot be performed without noticing the type of ETT and the presence or absence of thermosoftening. Namely, a double-blind study design may not be possible for the comparison of ETT tip types. Finally, the preoperative evaluation of nasal anatomy and the assessment of the postprocedure nasal complications were performed by the same otolaryngologist. Nonetheless, we think that an otolaryngologist who had no specific knowledge of the exact study design and grouping, would have no bias for the evaluation of nasal trauma.

During nasotracheal intubation, thermosoftening is recommended because it decreases the trauma from both the Murphy-tipped and the Magill-tipped PVC ETTs. Without thermosoftening, nasal mucosal trauma was more severe in the Murphy-tipped group than in the Magill-tipped group. Therefore, if one chooses to use a normal ETT, the Magill-tipped ETT should be used rather than a Murphy-tipped ETT.

References