Parker Flex-Tip and Standard-Tip Endotracheal Tubes: A Comparison During Nasotracheal Intubation

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The placement of endotracheal tubes in the airway, particularly through the nose, can cause trauma. Their design might be an important etiologic factor, but they have changed little since their introduction. Recently Parker Medical (Bridge-water, Conn) introduced the Parker Flex-Tip (PFT) tube, suggesting that it causes less trauma. This study aimed to compare the PFT endotracheal tube to a side-beveled, standard-tip endotracheal tube (ETT) for nasotracheal intubation (Figures 1 and 2). Forty consecutive oral surgery patients requiring nasotracheal intubation were randomized to receive either a standard ETT or the PFT tube. Intubations were recorded using a fiber-optic camera positioned proximal to the Murphy eye of the tube. This allowed visualization of the path and action of the tube tip as it traversed the nasal, pharyngeal, laryngeal, and tracheal airway regions. Video recordings made during intubation and extubation were evaluated for bleeding, trauma, and intubation time. Both bleeding and trauma were recorded using a visual analogue scale (VAS) and by 3 different evaluators. The PFT received significantly better VAS values than the standard tubes from all 3 raters ($P < 0.05$) in both the extent of trauma and bleeding. Since the intubations were purposefully conducted slowly for photographic reasons, neither tube displayed a time advantage. This study suggests that the PFT tube design may be safer by causing less trauma and bleeding than standard tube designs for nasotracheal intubation.

Key Words: Nasotracheal intubation; Parker Flex-Tip tube; Endotracheal intubation; Endotracheal tube; Fiber-optic intubation.

It is common practice to insert a nasotracheal tube to secure the airway, control ventilation, and provide accurate delivery of anesthetic gases during surgical procedures in the head and neck region. This serves to maintain the patency of the airway, prevent aspiration, and allow the anesthesiologist to control ventilation of the patient while remaining outside the surgical field. Specifically, nasotracheal intuba-

tion offers surgeons unimpeded access to the oral cavity and maxillofacial complex, free movement of the facial bones during orthognathic surgery, and reduction of facial fractures; and it permits correct articulation between the mandible and maxilla during surgical procedures. This method also allows dental surgeons unimpeded access to the oral cavity and dentition for extractions and endodontic and restorative treatment.

The standard nasotracheal tube supports an approximately 45°, side-beveled, distal tip that is designed to be directed toward the midline of the nasal cavity through the right naris. From this position it is ad-

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Figure 1. Standard (below) versus Parker (above) from side view.

vanced toward the pharynx and slid along the floor of the nasal cavity and septal wall, guided carefully down the posterior pharynx through the laryngeal structures and into the trachea.^{1,2}

The most common complications of nasotracheal intubation include epistaxis, mucosal abrasion, and a sore throat of short duration. Other potential complications described in the literature include case reports of retropharyngeal perforation, traumatic tissue avulsion (eg, mucosal enlargements such as polyps or parts of turbinates), lacerations of nasal and pharyngeal structures, infections subsequent to mucosal trauma, glottic edema, tracheal stenosis, vocal cord palsy, and arytenoid cartilage dislocation.^{2–6}

The following link to our video demonstrates the standard tube catching on the left vocal fold, whereas the PFT, identified by its blue stripe, smoothly passes through the glottis:

<http://dent.osu.edu/anesthesiology/article1/a.htm>

A link to our second video demonstrates the standard tube causing nasal hemorrhage:

<http://dent.osu.edu/anesthesiology/article1/k.htm>

Arytenoid cartilage dislocation can cause vocal fold immobility, and intubation is strongly associated with this problem. In fact, in a 20-year review of arytenoid cartilage dislocations, Rubin⁶ found that 77.8% of arytenoid cartilage dislocations were due to intubation trauma. Although very rare, injury from even short-term endotracheal intubation may lead to granuloma formation⁷ which, if symptomatic, can require further surgical intervention.⁸ During the past 10 years many efforts have been made to reduce the traumatic effects of nasal intubation. The literature describes many adjuncts that aim to decrease trauma and epistaxis such as nasopharyngeal airways, red rubber catheters, curved-tipped suction catheters, and inflated esopha-

Figure 2. Standard (below) versus Parker (above) from above view.

geal stethoscopes. Also described are variations in nasal intubation pathways¹ and evaluations of existing tube-tip designs.^{9–11}

The rigid nature of the more common ETT tip design is widely accepted. Therefore, it has become standard practice among dentist anesthesiologists to warm the tube in an attempt to soften its tip to reduce its propensity to cause damage to the delicate nasal mucosa. Examples of these methods include placing the tip of the ETT tube in warm water, lodging the tube next to a heated anesthetic vaporizer, and placing the tube in a blanket warmer.^{9,11–15}

The PFT tube features a centrally placed, flexible tip that tapers distally and a double Murphy eye proximal to the curved, rounded tip (Figures 1 and 2). The following links to our videos also provide a clear view of the anatomy of these 2 tubes and a comparison of the flexibility of their tips:

<http://dent.osu.edu/anesthesiology/article1/g.htm>

<http://dent.osu.edu/anesthesiology/article1/i.htm>

Anesthesiologists have reported that, even without attempting to soften the end of the PFT tube tip prior to insertion, the PFT tube is easier and perhaps faster to guide along a central pathway within the airway, and it causes fewer hang-ups on anatomical structures than standard tubes during oral intubation.¹⁶ Other reports indicate that during oral fiber-optic intubation, the PFT tube is less likely to traumatize the arytenoid cartilages as it slides over the fiberscope into the trachea.¹⁰ However, there is a lack of studies examining the method of nasotracheal intubation with the PFT tube. The purpose of this study was therefore to compare occurrence of bleeding and trauma along the airway during nasal intubation using 2 different tube types: a standard endotracheal tube and the PFT endotracheal tube.

Figure 3. Fiber-optic placement within tube.

METHODS AND MATERIALS

Following institutional review board approval, adult patients of The Ohio State University College of Dentistry's Oral and Maxillofacial Surgery Department who were (a) scheduled for an outpatient surgical procedure under general anesthesia requiring a nasotracheal intubation, (b) either American Society of Anesthesiologists physical classification I or II, (c) English speaking, and (d) nonpregnant were offered the opportunity to take part in this study. The first 40 volunteers were included. On the day of the consultation visit, patients fulfilling the inclusion/exclusion criteria were invited to participate in the study. Written informed consent was obtained from all volunteer patients. The subjects were randomly assigned an identification number from 1 to 40. The subjects receiving an even identification number received a standard tip endotracheal tube (Rusch) for their intubation and those receiving an odd number received the PFT tube.

Preparation of the Flexible Fiber-Optic Scope

A flexible fiber-optic scope was used to observe the action and effects of the 2 types of tubes during the intubation process rather than to physically guide the tubes through the airway as done during traditional fiber-optic intubation. Preparation consisted of placing a thin layer of water-soluble lubricating jelly over the distal end of the fiber-optic scope (Olympus OTV-S4, Olympus America Inc, Center Valley, Pa), and sliding it through a 6.5-mm i.d. endotracheal tube until the camera lens rested just proximal to the single or double Murphy eye (Figure 3). The scope was then secured via a padded clip at the proximal end of the ETT to prevent advancement of the scope beyond the

Murphy eye. This secured a uniform image for each procedure and prevented the frequently observed degradation of video images after contact between the fiberscope lens and the airway mucosa. The camera was white-balanced and focused before each intubation. Finally, a thin layer of 5% lidocaine ointment in a water-soluble base was applied to the distal end and cuff of the ETT to function as a lubricant.

Intubation

On the day of surgery, after reviewing the patient's medical history, confirming the presence of a responsible escort, verifying the patient's NPO (*nothing by mouth* [Latin]) status, and answering any remaining patient questions, staff escorted the patients to the surgical suite and seated them in a standard dental chair designed for oral surgery procedures. Appropriate ASA (American Society of Anesthesiologists) monitors were applied, which included a noninvasive blood pressure cuff, 5-lead electrocardiogram, finger pulse oximeter probe, temperature probe, and (after intubation) a gas analyzer to monitor end-tidal carbon dioxide, oxygen, and inspired inhalational agent concentrations (Passport 2 and Gas Module SE by Datascope). Intravenous access was obtained using a 20-gauge flexible angiocatheter. Fentanyl (1–2 mcg/kg) and oxygen were given 2 minutes before induction. Unconsciousness was induced with propofol (1.5–2.5 mg/kg) and, after demonstration of a patent airway, succinylcholine (1.5 mg/kg) was administered. The ETT was inserted slowly into the right naris, the tube being clearly observed via the scope during its passage past the intranasal structures and through the nasopharynx, oropharynx, and laryngeal inlet. The tube was passed through the larynx and advanced farther until the carina was seen, at which point intubation time was recorded. The fiberscope was then removed from the tube. Successful intubation was confirmed with the registration of end-tidal carbon dioxide and via bilateral auscultation of the lungs. A digital video of each individual intubation was recorded onto a computer.

Extubation

On completion of surgery the fiberscope was advanced once more through the ETT as described for the intubation. The cuff of the ETT was deflated and the patient was extubated as the tube with the secured fiberscope was slowly pulled back through the airway. As it was withdrawn, a digital video from the same perspective as the intubation was recorded to observe for evidence of trauma and bleeding.

Figure 4. Comparison of means: study population parameters.

Analysis

All 40 video clips were assigned a study number and provided for analysis by (a) the primary investigator, a senior dentist anesthesiology resident with a detailed understanding and experience of intubating the airway and who performed the intubations, (b) a dental assistant who had no knowledge of upper airway anatomy or the process of intubation, and (c) a chief resident in otolaryngology who had an in-depth knowledge of upper airway anatomy and the intubation process. Analysis consisted of a completed visual analogue scale (VAS) for both bleeding and trauma (erythema, lacerations, abrasions). The total time required for each intubation was also noted. To establish intrarater reliability, 10 of the 40 videos were randomly selected and reviewed again at a later date by all 3 reviewers. A compressed version of an intubation and an extubation video are included for reference:

<http://dent.osu.edu/anesthesiology/article1/c.htm>

<http://dent.osu.edu/anesthesiology/article1/e.htm>

RESULTS

A total of 40 patients between the ages of 18 and 65, meeting the inclusion/exclusion criteria for participation in this study, were accepted. The parameters of sex and age were similarly distributed in both groups. The “standard” group (group 1) had a mean age of 25 years and a 7:13 male-to-female ratio. The “Parker” group (group 2) had a mean age of 26 years and a 9:11 male-to-female ratio. Statistical analysis showed that the groups were similar in age and gender (Figure 4). Each of the subjects was nasally intubated suc-

Figure 5. Mean comparisons of visual analogue scale (VAS) data in response to bleeding. 0 = standard tube; 1 = Parker tube. Graph indicates 95% confidence intervals with no overlap of means interpreted as a significant difference in the means.

cessfully via the fiber-optic method described above. Neither a laryngoscope nor airway forceps was used in any patient. On 2 occasions we were unable to pass the endotracheal tube through the right naris. Without causing any obvious trauma, the tube was withdrawn and a subsequent attempt through the left naris proved successful in both subjects. During analysis of the resulting data however, these 2 observations, 1 from each group, were considered to be extreme outliers. The time recorded included the attempt to intubate through the right naris, the time to make the decision to change to the alternate side and the time taken to pass the endotracheal tube through the left nasal passage. This resulted in a greater than 3-fold mean intubation time. The total time taken did not reflect the time to intubate through one naris and, as a result, we made the decision to exclude these data points (1 from each group) from our statistical analysis. Additionally, because the tubes are designed to be optimally placed in the right naris, we excluded these 2 since left-side intubation might have been more traumatic. The total population consisted, therefore, of 38 participants. A 1-way ANOVA was used to compare the dependent variables of trauma, bleeding, and time to intubation, with the type of tube used being designated as the independent variable. The results of this analysis showed a significantly lower score on both the bleeding and trauma scales associated with the PFT tube. With respect to active bleeding, there was an 8.7-mm difference in the means of the 2 groups ($P = .0196$) on the VAS scores (Figure 5).

With respect to trauma, the PFT group registered a 9.1-mm lower score on the VAS, indicating a significantly lower trauma score ($P = .0126$; Figure 6).

Figure 6. Mean comparisons of visual analogue scale (VAS) data in response to trauma. 0 = standard tube; 1 = Parker tube. Graph indicates 95% confidence intervals with no overlap of means being interpreted as a significant difference in the means.

Additionally, the observations gathered were then categorized by tube type as having either some bleeding or no bleeding associated with the intubation; a 2-tailed Fisher's exact test was performed to analyze this association. It was found that there were significantly more patients who had bleeding after intubation with the standard tube than with a Parker tube type ($P < .0001$). This approach was repeated with the observations for trauma, and a similar result was found. There was a significantly greater probability of a patient's having visible trauma when using the standard tube ($P = .007$).

The time taken for intubation (Figure 7) with the standard tube (80.6 seconds) and the Parker tube

Figure 7. Comparison of means: intubation times.

Figure 8. Comparison of means: bleeding and trauma.

(77.6 seconds) did not vary significantly between the 2 groups ($P = .839$). Post hoc power analysis revealed that a difference in the means of 17 seconds would have been necessary to describe the 2 group samples as significantly different. Our observed difference was only 6.5 seconds.

Finally, a separate 1-way ANOVA was performed on the data compiled by the 3 separate raters and analyzed for significant variation between all variables (Figure 8). The analyses duplicated those of the initial results in that they continued to show a significant improvement of the PFT over the standard tube with regard to the amount of bleeding and trauma observed during intubation, with P values of .0037 and .0056, respectively (Figure 8). The data gathered from the re-analyzed video clips were taken, and intra- and interrater correlation coefficients were computed. Rater 1 (senior resident anesthesiologist) had an intrarater correlation coefficient of 0.96 with respect to bleeding and 0.97 with respect to trauma. Rater 2 (dental assistant) had an intrarater correlation coefficient of 0.97 with respect to bleeding and 0.84 with respect to trauma. Rater 3 (chief otolaryngology resident) had an intrarater correlation coefficient of 0.96 with respect to bleeding and 0.97 with respect to trauma. The interrater correlation coefficient was then determined using the combined data from all 3 raters and found to be 0.85 with respect to bleeding and 0.79 with respect to trauma.

DISCUSSION

In this study, the PFT tube caused significantly less trauma and bleeding compared with a standard-tip

Figure 9. The calculated probability that the reduced bleeding observed in this study using tube 1 was a chance occurrence is less than $P = .0001$. Grey = probability of no bleeding. Tube 0 = standard tube. Tube 1 = Parker tube.

tube during nasal intubation. The PFT tube seemed to glide rather than scrape over mucosal surfaces and surface irregularities such as the tracheal rings, and it was this property to which the observed differences were attributed. It was evident when reviewing the videos that the curved and slightly elevated tip of the PFT tube allows it to “surf” or “ski” along irregular surfaces and mucosal membranes, leading to less catching on the upper airway anatomical structures as viewed on the following links to our videos:

<http://dent.osu.edu/anesthesiology/article1/k.htm>

<http://dent.osu.edu/anesthesiology/article1/m.htm>

It was also noted that the path of travel of the PFT tube would alter more readily than the standard-tip tube. When the tube encountered resistance, the PFT tube tip would bend and redirect the tube, while the standard tube seemed to wedge against and bruise the involved mucosa. Sometimes the standard tube would tear the mucosa covering harder structures protruding into its path. This difference in flexibility was also evident as the tube passed the arytenoid cartilages. It was frequently noted that the PFT tube would glide over the cartilages and through the glottic opening, while the standard-tip tube would more frequently get caught against the cartilage structures, and then with added pressure or rotation of the tube, abruptly pass the cartilage structure. It should be noted, however, that in many cases both types of tubes, when advanced slowly under fiber-optic supervision, passed through the airway with very little or no trauma or bleeding.

VASs have been used successfully and reliably for many years for the assessment of patient subjective findings such as pain. The authors undertook the

Figure 10. The calculated probability that the reduced trauma observed in this study using Tube 1 was a chance occurrence is less than $P = .007$. Grey = probability of no trauma. Tube 0 = standard tube. Tube 1 = Parker tube.

study assuming that a VAS might also be a useful tool to assess bleeding and trauma, encouraged by the opinions of other authors and their experiences using VASs for subjective yet quantifiable data collection. Marsh-Richard et al have summarized some satisfactory uses of both the VAS and DVAS (discrete visual analogue scale). Both their and our search of PubMed confirm that indeed the VAS has been used and validated in its use for the assessment of quantifiable yet subjective observations in a number of areas dealing with parameters other than pain. These observations included health, self-perception, physician rapport, and assessment of symptoms and side-effects after pharmacological manipulations.¹⁷ The conduct of this study and our subsequent findings provided no indication that the use of a VAS suffered any obvious limitations during this study; indeed, it seemed to be a useful and easily interpreted tool for our researchers to use. The primary ANOVA analysis did show a difference between the 2 groups in both bleeding and trauma. However, it is hard to give clinical meaning to a difference of 8.7 mm and 9.1 mm, respectively. When we organized our data categorically, so that patients had either evidence of bleeding or no bleeding and either signs of trauma or no signs of trauma, a very clear difference was seen. The probability of having bleeding or trauma when using the Parker tube was significantly less, $P = .0001$ and $P = .007$, respectively (Figures 9 and 10).

With regard to the time required for intubation, our study failed to show a significant difference between the 2 tubes. Since all the intubations were deliberately conducted slowly to facilitate accurate fiber-optic observation and recording, this was not a surprising finding. It would be interesting to see how differences in

tip designs might affect the success and speed of blind nasal intubations, since that technique is still commonly used in outpatient centers, in urgent situations in the hospital, and in the field by emergency medical services personnel. The tip design directed a more centrally orientated passage of the PFT tube along the airway, and it may offer a clinical advantage over other designs for improving the success rate and speed of blind nasal intubation.

It was impossible to eliminate all bias in the current study. The distal end of both tubes could be visualized during intubation, thus permitting identification of the tube being used. We attempted to reduce or eliminate bias in the study by including one reviewer, a dental assistant, with little, if any, knowledge of intubation or the identification of the tubes used, as well as others with significant intubation experience. We were surprised by the correlation between the interclass and intraclass coefficients. Despite the variations in experience, understanding of the airway, and the process of intubation, all evaluators produced results very similar to each other.

Assessment of hard-to-quantify parameters, such as trauma, have plagued many studies. In an attempt to reduce the variability that often occurs when recording measurements having a subjective element to them, ten of the original videos were presented to the evaluators at a later date and in a different sequence, with the goal of estimating intra- and interrater reliability. We found that what was rated as moderate trauma or bleeding by an evaluator at one time was likely to be rated at the same level of trauma and bleeding by the same rater at a later date. In addition, a high degree of interrater reliability was demonstrated. What 1 rater described as moderate trauma was highly likely to be described in the same way by the other 2 evaluators. This interrater consistency not only strengthened the observational evidence that the PFT caused less trauma and bleeding during intubation, but also encouraged us to include this investigational structure in future projects of this nature.

CONCLUSION

The PFT tube was associated with significantly less trauma and significantly less bleeding during nasotracheal intubation when compared with the standard-tip tube. The unique design and flexible quality of the distal end of the endotracheal tube appears to be responsible for this advantage. Video recordings of the intubations demonstrate an extraordinary property of this tube to flex and maneuver safely past the complex nasal, pharyngeal, laryngeal, and tracheal anatomy.

REFERENCES

1. Ahmed-Nusrath A, Tong JL, Smith JE. Pathways through the nose for nasal intubation: a comparison of three endotracheal tubes. *Br J Anaesth*. 2008;100:269–274.
2. Hall CE, Shutt LE. Nasotracheal intubation for head and neck surgery. *Anaesthesia*. 2003;58:249–256.
3. Avrahami E, Frishman E, Spierier I, Englender M, Katz R. CT of minor intubation trauma with clinical correlations. *Eur J Radiol*. 1995;20:68–71.
4. Krebs MJ, Sakai T. Retropharyngeal dissection during nasotracheal intubation: a rare complication and its management. *J Clin Anesth*. 2008;20:218–221.
5. Tintinalli JE, Claffey J. Complications of nasotracheal intubation. *Ann Emerg Med*. 1981;10:142–144.
6. Rubin AD, Hawkshaw MJ, Moyer CA, Dean CM, Sataloff RT. Arytenoid cartilage dislocation: a 20-year experience. *J Voice*. 2005;19:687–701.
7. Kaneda N, Goto R, Ishijima S, Kawakami S, Park K, Shima Y. Laryngeal granuloma caused by short-term endotracheal intubation. *Anesthesiology*. 1999;90:1482–1483.
8. Lin D, Cheng S, Su W. Potassium tinctyl phosphate laser treatment of intubation vocal granuloma. *Eur Arch Otorhinolaryngol*. 2008;265:1233–1238.
9. Kim YC, Lee SH, Noh GJ, et al. Thermosoftening treatment of the nasotracheal tube before intubation can reduce epistaxis and nasal damage. *Anesth Analg*. 2000;91:698–701.
10. Kristensen MR. The Parker flex-tip tube versus a standard tube for fiberoptic orotracheal intubation: a randomized double-blind study. *Anesthesiology*. 2003;98:354–358.
11. Lee JH, Kim CH, Bahk JH, Park KS. The influence of endotracheal tube tip design on nasal trauma during nasotracheal intubation: Magill-tip versus Murphy-tip. *Anesth Analg*. 2005;101:1226–1229.
12. Enk D, Palmes AM, Van Aken H, Westphal M. Nasotracheal intubation: a simple and effective technique to reduce nasopharyngeal trauma and tube contamination. *Anesth Analg*. 2002;95:1432–1436.
13. Morimoto Y, Sugimura M, Hirose Y, Taki K, Niwa H. Nasotracheal intubation under curve-tipped suction catheter guidance reduces epistaxis. *Can J Anaesth*. 2006;53:295–298.
14. 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;105:1420–1424.
15. Watt S, Pickhardt D, Lerman J, Armstrong J, Creighton PR, Feldman L. Telescoping tracheal tubes into catheters minimizes epistaxis during nasotracheal intubation in children. *Anesthesiology*. 2007;106:238–242.
16. Guterierrez FA, Stene J, Schuler HG, Weigel W. A pilot study comparing the ease of intubation over an eschmann's stylette of the parker vs the mallinckrodt endotracheal tubes. *Anesthesiology*. 2001;95:A595.
17. Marsh-Richard DM, Hatzis ES, Mathias CW, Venditti N, Daugherty DM. Adaptive visual analog scales: a modifiable software program for the creation, administration and scoring of visual analog scales. *Behav Res Methods*. 2009;41:99–106.