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CORRESPONDENCE

Thermal softening of polyvinyl chloride nasotracheal tubes: effect of temperature on tube navigability

Enda Shanahan, MB, BCH, BAo, BSc(Med), FCAI · Charles V. Yu, BSc (Pharm) · Raymond Tang, MSc, MD, FRCPC · Andrew Sawka, BSc, MD, FRCPC · Himat Vaghadia, MBBS, FRCPC

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To the Editor,

We wish to share new findings on the optimal temperature for thermally softening nasal polyvinyl chloride (PVC) endotracheal tubes (ETTs) prior to nasotracheal intubation.

Thermal softening of nasal ETTs is an established method for reducing trauma to the nasal passages and laryngeal aditus during nasotracheal intubation.[1–3] The optimal temperature for thermal warming of polyvinyl chloride (PVC) ETTs, however, has not been established. In this bench study, we compared the mechanical properties of nasotracheal ETTs to determine the optimal temperature for thermal softening. We postulated that above a certain temperature nasal ETTs would become too soft and lose their rotational fidelity, such that the degree of rotation at the tube's proximal end would result in a lesser degree of rotation of the bevel. This change could lead to compromised ability to navigate through various airway structures and the laryngeal opening.[4,5]

Forty size 6.0 Mallinckrodt™ PVC nasal ETTs (Medtronic, Minneapolis, MN, USA) were equally divided into four groups (n = 10 each) based on the warming temperature: 40°C, 45°C, 50°C, 21°C (room temperature). The ETTs were completely immersed in a temperature-controlled Ecolab water bath (O.R. Solutions, Chantilly, VA, USA) containing normal saline and were heated for five minutes. A TruCorp AirSim Multinasal intubation manikin (TruCorp® Ltd, Belfast, Northern Ireland) was prepared with lubrication in the nasal passages. An Ambu® aScope™ 2 (Ambu A/S, Baltorpbakken, Denmark) flexible fibreoptic scope with a monitor was then advanced retrogradely up the right main bronchus and trachea of the manikin and positioned with the tip of the scope at the level of the vocal cords (Figure). An experienced anesthesiologist advanced the ETT through the nasopharynx of the manikin until the bevel approached the tip of the scope. At that point, the proximal end was rotated 180° anti-clockwise. Observing the fibreoptic scope's monitor, a second investigator estimated the degree of bevel rotation by applying a standard protractor to the screen. A continuous line denoted on the posterior side of the ETT (inherent to this particular tube) was used as a landmark.

Figure TruCorp AirSim® Multi nasal intubation manikin (TruCorp® Ltd, Belfast, Northern Ireland) and the Ambu® aScope™ 2 (Ambu A/S, Baltorpbakken, Denmark) flexible intubation fibreoptic scope with monitor used in the study

E. Shanahan, MB, BCH, BAo, BSc(Med), FCAI · R. Tang, MSc, MD, FRCPC · A. Sawka, BSc, MD, FRCPC · H. Vaghadia, MBBS, FRCPC
Department of Anaesthesia, Vancouver Coastal Health, Vancouver, BC, Canada

C. V. Yu, BSc (Pharm) (✉)
Faculty of Medicine, University of British Columbia, Vancouver, BC, Canada
e-mail: charles.v.yu@alumni.ubc.ca

The observer and anesthesiologist were blinded to the temperatures of the ETTs, which were provided in randomized sequence by a third investigator. The time that elapsed between withdrawing the ETT from the water bath to placing it in the manikin (less than ten seconds) and the time between withdrawing the ETT from the water bath to completing the rotational measurements (two to three minutes) were consistent among the groups. To ensure that the airway of the manikin was not overly warmed, there was a five-minute delay between tube insertion trials.

Our results demonstrated that when the proximal end of a PVC nasal ETT was rotated 180°, the average bevel rotations of the distal end were 119°, 119°, 92°, and 53° at 21°C, 40°C, 45°C, and 50°C, respectively. Kruskal-Wallis and Mann-Whitney U tests revealed a statistically significant difference among the groups ($P < 0.001$).

Our findings suggest that thermal softening of PVC nasal ETTs by thermally warming them at temperatures above 40°C results in reduced rotational fidelity and ETT navigability. These reductions may have some clinical relevance as the benefits of thermal softening in reducing the risk of epistaxis has been established at approximately 40°C,[1] suggesting that heating the tube to more than 40°C poses little benefit and may unnecessarily expose the patient to such risks as thermal injury and a difficult intubation.

Limitations to this study include the use of a manikin and uncertain clinical applicability. Our results do not apply to nasal ETTs made of other materials. Further investigation is warranted to determine if their navigability is similarly affected by thermal warming.

In conclusion, 40°C may be the optimal temperature for ETT thermal softening prior to nasotracheal intubation.

Conflicts of interest None declared.

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References

1. *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.
2. *Hosseinzadeh H*, *Talesh KT*, *Golzari SE*, *Gholizadeh H*, *Lotfi A*, *Hosseinzadeh P*. Warming endotracheal tube in blind nasotracheal intubation throughout maxillofacial surgeries. J Cardiovasc Thorac Res 2013; 5: 147-51.
3. *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: 269-74.
4. *Asai T*, *Shingu K*. Difficulty in advancing a tracheal tube over a fibreoptic bronchoscope: incidence, causes and solutions. Br J Anaesth 2004; 92: 870-81.
5. *Marfin AG*, *Iqbal R*, *Mihm F*, *Popat MT*, *Scott SH*, *Pandit JJ*. Determination of the site of tracheal tube impingement during nasotracheal fibreoptic intubation. Anaesthesia 2006; 61: 646-50.