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Randomized comparison of experts and trainees with nasal and oral fibreoptic intubation in children less than 2 yr of age

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Editor's key points

- Fibreoptic tracheal intubation is the gold standard for difficult airway management.
- The authors studied the influence of route and operator experience on time to successful intubation.
- For experts, there was no difference in intubation times between the nasal and oral routes.
- For trainees, intubation times were shorter with the nasal route.

Background. We hypothesized that the time to successful fibreoptic tracheal intubation through the nasal route would be faster than the oral route for both experts and trainees in children <2 yr of age.

Methods. One hundred children, 24 months and under in age, were randomized to an operator (expert or trainee), and route (nasal or oral) for fibreoptic tracheal intubation. Three separate times were then measured: (i) time to first glottic view, (ii) time to carinal view, and (iii) total time to successful tracheal intubation. The number of attempts made, manoeuvres needed to obtain an adequate laryngeal view, and manoeuvres for tracheal tube passage were also recorded.

Results. Time to successful tracheal intubation was significantly faster for experts than trainees. There was no difference in the time to tracheal intubation between the nasal and oral routes for experts. In trainees, intubation times were shorter for the nasal route—median (inter-quartile range) time (s) to carinal view was 35 (27–63) for the nasal route *vs* 59 (38–94) for the oral route (P=0.03), and the median time to successful tracheal intubation were 62 (49–122) *vs* 117 (61–224), P=0.05, for the nasal and oral routes, respectively. For trainees, the oral route required a greater number of airway manoeuvres for adequate laryngeal views and passage of the tracheal tube compared with the nasal route.

Conclusions. For clinicians with less experience in using paediatric bronchoscopes, fibreoptic tracheal intubation through the nasal route may be a more straightforward process than the oral route in children <2 yr of age.

Clinical trial registration. NCT02029300 (www.clinicaltrials.gov).

Keywords: airway; children; larynx, laryngoscopy fibreoptic

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Management of the difficult airway in young children can pose a very challenging scenario. Additionally, infants reportedly have a higher incidence of difficult laryngoscopy,[1] and are prone to rapid oxygen desaturation due to their higher rate of oxygen consumption. Therefore, less experienced clinicians, including trainees, may have the most to gain from learning techniques to improve their success in paediatric airway management.

Fibreoptic-guided tracheal intubation remains the 'gold standard' for paediatric difficult airways,[2–6] and is an essential skill for anyone practicing paediatric anaesthesia.[3 5–7] The smaller diameter, greater flexibility, and reduced tip angulation of the paediatric fibreoptic bronchoscope make manoeuvrability more difficult and harder to master.[8] Under the age of 24 months, the paediatric larynx differs from adults. The anatomical features of this age include a more cephalad larynx, floppy epiglottis, large tongue relative to the oropharyngeal space which can add to the challenge of navigating the fibreoptic bronchoscope with the traditional oral approach, and may also affect the ease of tracheal tube passage.[9–12] The nasal approach may potentially overcome some of these challenges by stabilizing the bronchoscope in the midline position, allowing for a more straightforward pathway to the larynx.[11 13]

We are not aware of any studies that compare operator experience with both nasal and oral fibreoptic-guided tracheal intubation in smaller children. The purpose of this randomized study was to make this comparison and assess the potential advantages of nasal fibreoptic-guided tracheal intubation. We hypothesized that the time to successful fibreoptic-guided tracheal intubation with the nasal route would be faster than the oral route for both experts and trainees in children <2 yr of age.

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Methods

This study was approved by the Ann & Robert H. Lurie Children's Hospital's Institutional Review Board. Written informed consent was obtained from the guardians of all patients. Registration for this study can be found at http://clinicaltrials.gov/show/NCT02029300. One hundred children ASA I–III who were 24 months and under in age, and undergoing procedures (craniosynostosis repairs, craniotomies, spinal cord procedures, branchial cleft cyst excisions, and some intra-oral procedures) where both nasal and oral tracheal intubation could be used interchangeably and consistent with the clinical practice of the investigators, were enrolled in this study. Children with active upper respiratory infection, significant pulmonary disease, a known history and/or suspicion of difficult airway, airway abnormalities, active gastrointestinal reflux, coagulopathy, specific procedures such as cleft palate where nasal intubation would not be suitable were not enrolled in the study.

A computer-generated randomization was utilized, to designate the operator (expert or trainee), and route of fibreoptic tracheal intubation (nasal or oral). An expert was defined as an attending anaesthesiologist who had performed more than 100 fibreoptic tracheal intubations on paediatric patients, and were used as the control group. A trainee was defined as an anaesthesia trainee, Clinical Anaesthesia (CA) years 2, 3, or 4, who had performed three or less fibreoptic tracheal intubations in children under the age of 2 yr. All trainees had minimal prior experience with fibreoptic-guided nasotracheal intubation. Their participation was voluntary and their prior oral fibreoptic-guided tracheal intubation experience in adult patients was verified through a written questionnaire and each individual trainee's case logs. Each trainee was allowed to participate in the study no more than three times to minimize a learning effect from repeated experience.

All patients received general anaesthesia with inhalation induction using nitrous oxide 70% in 30% oxygen and 8% sevoflurane. A peripheral i.v. line was then placed, and rocuronium 0.6 mg kg^{-1} was administered. Nitrous oxide was then discontinued and sevoflurane was maintained with an end-tidal concentration of 3%, and an end-tidal oxygen concentration >90% before all fibreoptic tracheal intubations. Oropharyngeal suctioning was performed on all patients before tracheal intubation. The fibreoptic bronchoscope (Olympus LF-P or 2.2 mm, LF-DP 3.7 mm diameter; Tokyo, Japan) was loaded with an appropriately sized standard cuffed tracheal tube (Mallinckrodt; Mansfield, MA, USA) based on the patient's age. All fibreoptic-guided tracheal intubations were performed with a video tower to visualize the intubation process on an external monitor.[8] Three separate times were then measured by an independent observer, all beginning with the removal of the facemask: (i) time to first glottic view: defined as the duration of time ending with the first view of the glottic opening. (ii) Time to carinal view: defined as the duration of time ending with visualization of the carina. (iii) Time to successful tracheal intubation: defined as the duration of time ending with the observation of the third square wave end-tidal capnogram after successful tracheal intubation. In the oral group, the mouth of the child was held open by one of the study investigators for placement of the fibreoptic bronchoscope. Children in the nasal group received the following preparations: oxymetazoline hydrochloride drops administered into the nare to reduce the risk of nasal epistaxis,[14] followed by placement of an appropriately sized nasal trumpet (Teleflex Medical; Kamunting, Malaysia) to dilate and assess the patency of the nare and then removed before intubation. If resistance was encounter with the nasal trumpet, the clinician was allowed to utilize the contralateral nare. If the nasal trumpet could not be passed through either nare, the patient would be excluded from the study. All tracheal tubes (nasal route) were thermosoftened in warm normal saline.[15–17] All fibreoptic intubations (oral and nasal) were performed with the tracheal tube preloaded onto the fibreoptic bronchoscope.

The clinician randomized for this study was allowed a total of three attempts for successful fibreoptic-guided tracheal intubation. The lungs were ventilated with 100% oxygen in between attempts. The time was restarted in between each attempt. A failed attempt was defined as any evidence of oxygen desaturation (Sp_{O_2} <90%), any time the bronchoscope had to be withdrawn completely from the nares or mouth (i.e. secretions, disorientation, or oxygen desaturation), or requiring more than 3 min.[8] Outright failure was defined as the inability to successfully intubate the trachea within three attempts, if nasal obstruction was encountered preventing the use of the nasal route, or if it was not feasible to continue with fibreoptic-guided tracheal intubation (such as bleeding). If tracheal intubation was unsuccessful for any of the above reasons, the trachea would be intubated by direct laryngoscopy. Intraoperative complications such as oxygen desaturation, laryngospasm, bronchospasm, and bleeding (epistaxis or from suctioning) were recorded.

Airway manoeuvres such as jaw thrust, tongue withdrawal by digital traction, neck extension/flexion, or anterior laryngeal pressure were allowed to improve the laryngeal grade of view and/or passage of the tracheal tube during fibreoptic intubation.[17] These manoeuvres were only performed by the experts if indicated (suboptimal laryngeal view/resistance to tracheal tube passage), and the total number of manoeuvres needed was recorded. An optimal laryngeal view was defined as the ability to visualize the entire glottic opening. In the trainee group, the expert study investigators were allowed to give verbal cues to advise the trainees in times of disorientation or if issues with tracheal tube passage occurred. The number of cues needed was also recorded. Verbal cues were offered when prompted by the trainee ('unsure of where I am'), if disorientation occurred (red opaque screen visualized by the attending anaesthesiologist with no purposeful movement of the bronchoscope by the trainee) or if there was difficulty in tracheal tube passage. The verbal cues offered by the attending anaesthesiologist were standardized and included: to 'keep the bronchoscope midline', to withdraw/advance/rotate the bronchoscope, and/or to rotate the tracheal tube.

The tracheal tubes were oriented with the bevel up (nasal) or bevel down (oral) during passage of the tracheal tube to facilitate successful placement into the trachea.[18] Subjective

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