Original Article

Nasotracheal Intubation in Children for Outpatient Dental Surgery: Is Fiberoptic Bronchoscopy Useful?

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Abstract

Background: The aim of our study was to compare the hemodynamic responses and adverse events associated with nasotracheal intubation (NTI) using a fiberoptic bronchoscope (FOB) and a direct laryngoscope (DLS) in children undergoing general anesthesia for outpatient dental surgery. **Methods:** Eighty children (aged 5–15 years) were scheduled to undergo outpatient dental surgery under general anesthesia and of these children those who required NTI were included. **Results:** NTI was significantly longer in the FOB group (P = 0.03). In both groups, systolic blood pressure (SBP) and heart rate (HR) significantly decreased after the induction of anesthesia when compared with the baseline values. SBP was significantly higher in both groups at intubation and 1 and 3 min after intubation when compared with postinduction. SBP significantly increased in the DLS group compared with the FOB group at intubation and 1 min after intubation. HR was significantly increased at intubation and 1 min after intubation in the DLS group compared with the FOB group. Nose bleeding after intubation was significantly more frequent in the DLS group (30%) than in the FOB group (7.5%) (P = 0.034). The incidence of sore throat 24 h after surgery was 20% (8/40) in the DLS group and 2.5% (1/40) in the FOB group (P = 0.014). **Conclusions:** There are fewer hemodynamic responses and adverse events in the FOB group than in the DLS group; therefore, FOB can be safely used for NTI in children undergoing outpatient dental surgery, and FOB may be more successful than DLS for NTI.

Keywords: *children, dental surgery, fiberoptic intubation, nasotracheal intubation*

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Introduction

Nasotracheal intubation (NTI) is a technique that is performed to ensure airway control during dental surgery.[1] NTI is generally completed in three phases: nasopharyngeal intubation, direct laryngoscopy to visualize the vocal cords, and passing of the tube to the trachea.[2] NTI can be performed with a fiberoptic bronchoscope (FOB) or a direct laryngoscope (DLS). NTI causes distinctive hemodynamic responses depending on the stimuli to the larynx and the trachea. Some studies have claimed that several structures such as the arytenoid,[3] the tongue,[4] and the epiglottis[5] are responsible for these hemodynamic changes during nasal fiberoptic intubation. Intubation with FOB can minimize pharyngeal mechanical stimulations and decreases hemodynamic responses during NTI.[6] Hemodynamic responses to FOB-guided intubation have been extensively studied in children and adult for the comparison of oral and nasal routes.[7,8] Lubricants, vasoconstrictors, lidocaine, anesthetic agent choice, and anesthesia depth are important for controlling the hemodynamic changes during NTI. There is no study comparing the hemodynamic responses to NTI with FOB and DLS in children undergoing general anesthesia

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for outpatient dental surgery. The aim of our study was to compare the hemodynamic responses and adverse events associated with NTI using an FOB or DLS in children undergoing general anesthesia for outpatient dental surgery. We hypothesized that FOB-guided NTI would be more successful than DLS-guided NTI in children.

Methods

We obtained confirmation from the Inonu University Medical Faculty Hospital Ethics Committee (2015/101) and written informed consent from the guardians of all 80 children. These children, who had an ASA physical status of I–II, had a Mallampati Score of 1–2, were aged 5–15 years, scheduled to undergo outpatient dental surgery under general anesthesia and required NTI were included in this prospective and randomized study. Exclusion criteria included the following: the patient's refusal for study consent, active upper respiratory infection, airway abnormalities, nasal mass or nasal injury, bleeding disorders, allergies to anesthetics, uncontrolled hypertension, morbid obesity, hepatic or renal failure, cardiovascular diseases, a history of nasopharyngeal surgery, and those who were difficult to intubate. Children were randomly assigned into the DLS group (n = 40) or the FOB group (n = 40) according to a computer-randomized table. General anesthesia was administered to children due to the learning difficulties. The number of models was decided by a statistical power analysis after the conclusions from the pretest were obtained. The general data of the children in the two groups are shown in Table 1.

All of the children fasted at least for 6 h before surgery and the oral intake of clear fluids was restricted for 2-3 h. Premedication of midazolam (0.5 mg/kg) was orally administered in apple juice (0.5 ml/kg of body weight) 1 h prior to anesthesia. After being admitted to the operating room, the patient's systolic blood pressure (SBP) and heart rate (HR) were continually monitored with a multichannel physiologic monitor (Dateks Ohmeda F-CU8; Datex Instrumentarium, Helsinki, Finland) and the baseline values for SBP and HR were recorded. Thirty minutes before the intubation attempt, the nasal mucosa of both nostrils were anesthetized with a topical vasoconstrictor (0.05% xylometazoline spray, and 2% lidocaine 1 ml two times in each nostril)[9] to attenuate cardiovascular responses and adverse events in all children. Anesthesia was induced with 8% sevoflurane with eight deep breaths via a face mask and the patient was maintained on 4% end-tidal sevoflurane, fentanyl 2 μg/kg and rocuronium 0.6 mg/kg. NTI was achieved 2 min after rocuronium injection. The more patent nostril was selected for intubation. An experienced anesthetist performed all intubations in the study and an assistant applied the maneuvers (jaw trust) and evaluated the patient during the postoperative visits. All NTI, both DLS and FOB, were conducted by the same experienced anesthetist (the anesthetist had performed DLS and the FOB nasal intubation in more than 150 patients, including in at least 100 children before the study). A study nurse documented the anesthetic data and timing. In the DLS group, the spiral tube was inserted into the nose and intubated with a Macintosh laryngoscope (Timesco, London, England) according to conventional procedures using Magill forceps. In the FOB group, NTI was conducted using an FOB with an outer diameter of 3.1 mm (Olympus LF-DP, Tokyo, Japan) through the selected clear nasal passage with a spiral tracheal tube. The appropriate size of the tracheal tube for a child was determined with the following formula[10]: ID (mm) = age/3 + 3.5 in both groups. The same type of tube was used in each group. Before intubation, enough lidocaine gel was placed on the tracheal tube and the FOB was guided into patients with a suitable spiral tracheal tube. All tracheal tubes were cuffed and thermosoftened in warm normal saline and lubricated to reduce mechanic stimuli to airway structures. During the intubation, the head of the patient was the in supine position and an assistant applied a jaw thrust maneuver for opening the nasopharyngeal passage and improved the image in all patients in the FOB group. If indicated (a suboptimal laryngeal view or resistance in passing of the tracheal tube), anterior laryngeal pressure and tongue withdrawal by digital traction was performed to improve the laryngeal field of view, and this procedure was recorded.[11] When the glottis was clearly visible, the FOB was advanced through the vocal cords and jaw thrust maneuver was released. To prevent the stimulation of the carina, the tube was placed 4 cm below the glottis, sliding over the FOB. Intubation was verified with FOB and end-tidal CO_2 concentrations at 35–40 mmHg were monitored. A throat pack was inserted by the anesthetist after the measurements were taken. Anesthesia was maintained with 2% sevoflurane and 50% N_2O in oxygen with 1.5 l/min fresh gas flow and 35-40 mmHg end-tidal CO_2 concentrations. Isolyte-P was administered at rate of 15 ml/kg/h IV and acetaminophen (15 mg/kg) was infused for postoperative analgesia in all children.

SBP and HR were recorded at baseline, after induction of anesthesia, at the time of intubation, and 1, 3, and 5 min after intubation. The intubation time (the time from when manual ventilation with a facemask stopped to restarting ventilation via the nasotracheal tube and when

carbon dioxide (CO_2) was detected by capnography) was recorded by another anesthetist with a digital stopwatch. Nose bleeding after intubation (epistaxis), laryngospasm, bradycardia (HR < 65 beats/min), hypoxic episodes (SpO_2 < 90%) and the surgery type were also recorded. Adverse events (hoarseness, sore throat) were assessed 24 h after surgery. If a sore throat developed, additional analgesics were not administered. If bradycardia or desaturation (SpO_2 < 90%) occurred for more than 2 min, the intubation was interrupted and patients were ventilated with 100% oxygen and were administered IV atropine (5-10 μg/kg).

Statistical Analysis

The data were expressed as the mean (standard deviation, SD) or frequencies with percentages, depending on the overall variable distribution. Normality was assessed using the Shapiro–Wilk test. Normally distributed data were analyzed by the independent samples *t* test. Qualitative data were analyzed using the Pearson chi-square test, Yates corrected chi-square test, and Fisher exact test, as appropriate. $P < 0.05$ values were considered statistically significant. IBM SPSS statistics version 23.0 for Windows was used for statistical analyses. The number of models was decided by a statistical power analysis after the pretest conclusions were obtained. Power analysis was used to define the minimal clinically important difference in SBP to be 20 mmHg and a standard deviation of residuals was anticipated to be 12.5 mmHg. Therefore, a sample size of 26 children in each group was required for an α of 0.05 and a β of 0.2. To define a 30% difference in the incidence of side effects, 40 children in each group were for an α of 0.05 and a β of 0.2.

Results

A total of 80 children aged 3-15 years (mean 7.3) were enrolled into the study. There was no significant difference in the demographic data between the two groups [Table 1]. NTI was completed in 52.9 ± 5.1 s (range 42-64 s) in the FOB group and 37.4 ± 4.5 s (range 31–45 s) in the DLS group [Table 1]. NTI was significantly longer in the FOB group ($P = 0.03$). Neither bradycardia nor desaturation were seen for more than 2 min. NTI with the first attempt was 87.5% ($n = 35$) in the FOB group and 90% ($n = 36$) in the DLS group. There was no significant difference in the first attempt for both groups. The FOB group required jaw thrusts in all children when intubating these patients under general anesthesia. All patients were selected from the outpatient anesthesia surgical procedure. The types of surgery are shown in Table 2. All of the surgeries took less than 2 h and the complexity of the surgeries was similar.

SBP and HR decreased significantly after the induction of anesthesia in both groups compared to the values at baseline. SBP and HR were not significantly different between the two groups after the induction of anesthesia. SBP was lower in both groups at the postinduction period compared with the baseline values. SBP was significantly higher in the two groups at the time of intubation and 1 and 3 min after intubation compared with the postinduction period. SBP was significantly increased in the DLS group compared with the FOB group at the time of intubation and during the first min after intubation. HR was significantly increased at the time of intubation and during the first min after intubation in the DLS group compared with the FOB group. HR was higher in the two groups at the time of intubation and 1, 3, and 5 min after intubation compared with the postinduction period [Figures 1 and 2].

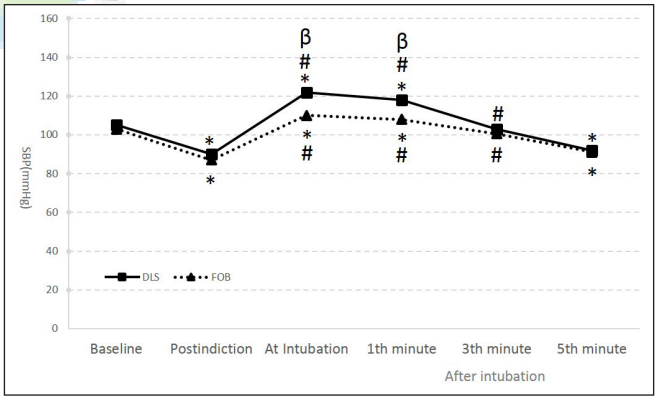

Figure 1: Systolic blood pressure. $n = 40$ for each group, DLS = direct laryngoscope, FOB = fiberoptic bronchoscope, SBP = systolic blood pressure, * $P < 0.05$ compared with baseline values, $^{\#}$ $P < 0.05$ compared with postinduction, $^{\beta}$ $P < 0.05$ compared with FOB group

Table 1: General data

Group	n	Male/Female	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m2)	MPS (1/2)	Intubation timea (s)
DLS	40	26/14	7.4 ± 3.1	25.6 ± 11.1	113.2 ± 15.8	18.7 ± 4.1	17/23	37.4 ± 4.5 (31– 45)**
FOB	40	25/15	7.3 ± 3.2	24.5 ± 9.08	109.3 ± 15.8	19.3 ± 3.1	15/25	52.9 ± 5.1* (42–64)**

DLS: direct laryngoscope; FOB: fiberoptic bronchoscope; BMI: Body Mass Index; MPS: Mallampati Score. *$P < 0.05$ comparasion between two groups; **Range of intubation time; [a]The period from termination of manual ventilation using facemask to restarting of ventilation via tracheal tube.

Table 2: The type of surgery

Group	n	Tooth extraction	Filling	Tooth extraction + filling	Tooth abscess
DLS	40	0	3	36	1
FOB	40	1	4	35	0

DLS = direct laryngoscop, FOB = fiberoptic bronchoscope.

Table 3: Adverse events

	Group DLS n (%)	Group FOB n (%)
Nose bleedinga	12 (30%)*	3 (7.5%)
Bradycardiab	3 (7.5%)	2 (5%)
Laryngospasmb	0 (0.0%)	0 (0.0%)
Hypoxiab	2 (5%)	3 (7.5%)
Hoarsenessc	1 (2.5%)	0 (0.0%)
Throatachec	8 (20%)*	1 (2.5%)

DLS: Direct laryngoscope; FOB: Fiberoptic bronchoscope. *$P < 0.05$, comparasion between two group; [a]Nose bleeding after intubation; [b]during nasotracheal intubation; [c]24 h after surgery

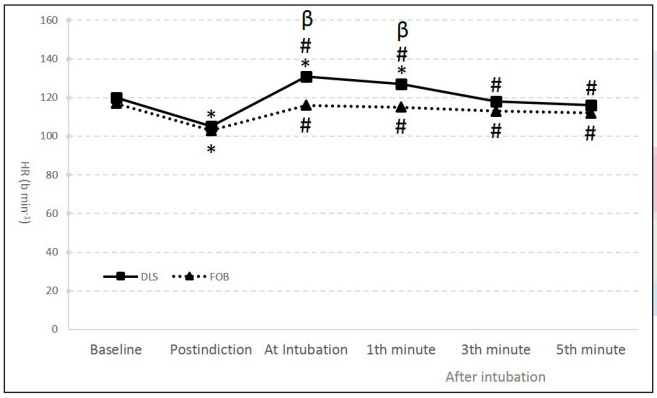

Figure 2: Heart rate. $n = 40$ for each group, DLS = direct laryngoscope, FOB = fiberoptic bronchoscope, HR = heart rate. * $P < 0.05$ compared with baseline values, # $P < 0.05$ compared with after anesthetic induction, β $P < 0.05$ compared with FOB group

Adverse events are shown in Table 3. Nose bleeding after intubation was significantly more frequent in the DLS group (30%) than the FOB group (7.5%) ($P = 0.034$). The incidence of sore throats 24 h after surgery was 20% (8/40) in the DLS group and 2.5% (1/40) in the FOB group ($P = 0.014$). There was no significant difference in the incidence of hypoxia, bradycardia, or hoarseness between the two groups. There were no children who developed laryngospasms.

Discussion

FOB and DLS are safe and useful equipments. They can be easily used by experienced anesthetists[12] in children who are undergoing NTI and may be the preferred equipment during lengthy dental procedures in children. One common cause of changes in hemodynamic values is the stimulation of pharyngeal and tracheal structures.[13] Shribman *et al*.[14] found that there were significant and similar increases in arterial pressure and circulating catecholamine concentrations following laryngoscopy with or without intubation. NTI in children can be difficult due to the anatomy of anterior larynx, short necks and a more anteriorly angulated larynx.[15] Hemodynamic responses to nasotracheal or orotracheal intubations were compared using an FOB or a DLS in adults and children,[1,2,16] but no previous study had compared FOB and DLS for children undergoing NTI for outpatient dental surgery. Our data indicated that NTI with a DLS significantly increases SBP and HR in children. A significant increase in HR in the DLS group was observed in all measurements after intubation. Except for HR, the hemodynamic values at 3 min after intubation were found to be close to the baseline in both the groups. DLS can directly stimulate the base of the tongue and the epiglottis, which also leads to an increase in hemodynamic values. Although an increase in hemodynamic values after intubation was significant when compared with the baseline values in both groups, these increases were significant in only the DLS group. This finding may be because the tube and the FOB are advanced by aligning the equipment with the larynx and the trachea, resulting in less friction and stimuli. Results from another study showed that HR and BP after intubation were significantly lower in FOB nasotracheal group than FOB orotracheal group in children.[7] Xue *et al*.[17] stated that orotracheal intubation using FOB or DLS can cause similar hemodynamic responses in children. Shibata *et al*.[8] demonstrated that the cardiovascular responses to nasal fiberoptic intubation are more severe than those with oral fiberoptic intubation, as fiberoptic intubation takes a longer time and requires multiple manipulations. The diameter or type of tracheal tube and fiberscopes, the use of lubricants, jaw and head–neck movements, the cricoid pressure, and the rotation of the tracheal tube can result in different effects depending on the chosen technique.[18,19] Hirabayashi *et al*.[20] founded that grasping and lifting the jaw were enough to increase the hemodynamic responses like DLS. However, in Hirabayashi's study, the anesthetist applied a jaw thrust with his other hand while implementing the fiberoptic nasal intubation in adults. We can easily apply airway maneuvers such as jaw thrust with less energy in children compared with adults by grasping and lifting with the thumb and the index finger. Tong *et al*.[16] indicated that lingual traction with jaw thrust maneuver led to a decreased response to stimuli during NTI using an FOB by an experienced anesthetist. Therefore, in our study, all airway maneuvers were applied by an

experienced anesthetist and lingual traction and anterior laryngeal pressure were not applied.

Intratracheal stimulations during tracheal intubation are important for hemodynamic changes.[6] Tracheal stimulations with the FOB are also minimal if the procedure is conducted by experienced practitioners. To determine the dominant nostril, the patient can be consulted by the otolaryngologist. This approach may help to suppress hemodynamic responses allowing the selection of the appropriate nostril.

The dose and duration of fentanyl application that minimize changes in hemodynamic responses is controversial. Adachi *et al*.[21] suggested that fentanyl (2 μg/kg) IV administered 2 min before intubation decreases hemodynamic responses in adults who are intubated. In children, we should note the dose of fentanyl because of its adverse effects, which include bradycardia, hypotension, and a delayed recovery. Some studies have reported that fentanyl (3 μg/kg) IV administered 5 min before the induction of anesthesia is an effective practice that abolishes the responses of intubation in children.[7,17,22] We used fentanyl (2 μg/kg IV) 2 min before intubation to minimize the hemodynamic responses of intubation.

NTI with FOB takes more time than DLS. DLS is a more invasive procedure because a flexible endotracheal tube is blindly inserted through the nostril. FOB enables us to use the best nasal cavity. A long duration of tracheal intubation causes apnea and hypoxia in patients and using FOB is difficult in anticipated difficult intubation. In our study, we observed that the intubation time was significantly longer in the FOB group than DLS group and the frequency of hypoxia was 7.5% (3/40). The NTI time using DLS was 37 (31–45) s which was similar to the findings in the study by Singh *et al*.[2]. Xue *et al*.[7] found that the NTI time using FOB was 42.4 ± 13.3 s. Jagannathan *et al*.[23] demonstrated that intubation time was 39 (35–53) s when an experienced anesthetist used an FOB in children less than 2 years of age. The intubation time was shorter than our practice (52.9 ± 5.1 s), which may be due to a difference in the experience in using fiberoptic bronchoscopy. However, a longer intubation time can be an issue in children with potentially difficult intubation or airway. A videolaryngoscope can be tested in patients with difficult airways and NTI. Further studies are needed in this regard.

Adverse events during NTI should be considered when using an FOB or a DLS. Epistaxis is an expected adverse event of NTI as high as 80%.[9] The choice of the more potent nostril, the use of water-soluble lubricants, the selection of smaller tracheal tubes, the use of thermosoftened tracheal tubes,[24] and topical vasoconstrictors are effective in decreasing the risk of epistaxis. In our study, nose bleeding after intubation was significantly more frequent in the DLS group (30%) ($P = 0.034$). El-Seify *et al*.[9] indicated that epistaxis was observed in 7.5% of NTI patients with DLS, which is consistent with the results from our study. Bradycardia may be observed due to the stimulation of the nasal mucosa, leading to the nasocardiac reflex.[25] In our study, we observed bradycardia in 3 (7.5%) children in the DLS group and in 2 (5%) children in the FOB group, but there was no significant difference between these two groups. A study reported that bradycardia was observed in 2 (10%) adults with NTI. The incidence of sore throat 24 h after surgery was 20% (8/40) in the DLS group and 2.5% (1/40) in the FOB group ($P = 0.014$). We think that this finding was dependent on gentle maneuvers in the FOB group. Asai *et al*.[11] noted that the incidence of sore throat was 10% (2/20) in patients who were anticipated to have difficult airways. Although NTI with FOB may take a significantly longer time, it may be better for NTI in children because it is associated with fewer adverse effects.

Patients are generally children who have some syndromes in outpatient dental surgery undergoing general anesthesia. We may encounter difficult airway or anatomical changes about nasal passage and pharynx that are not caused difficult airway in these patients who have growth retardation or cerebral palsy. We chose patients with normal airway and wanted to standardized the study. NTI routinely applies to patients who need to dental surgery in our clinic.

There are some limitations to our study. First, the depth of anesthesia can affect the hemodynamic responses in patients who undergo NTI. An increase in anesthetic depth reduces responses to stimuli applied to the pharyngeal structure by DLS or FOB. Setting the appropriate depth of anesthesia might suppress the hemodynamic responses to tracheal intubation using an FOB or a DLS.[17] Second, we accepted children with normal airways and normal cardiopulmonary physiology; therefore, these results may not apply to children with abnormal airways and altered cardiopulmonary physiology. Third, a neuromuscular agent was administered to all children, and the tone of the airway structures decreased. The variable effects of inhalational anesthetics in the patient, the inhaled anesthetic concentrations during facemask ventilation, the effectiveness of lidocaine and vasoconstrictors in the nasal cavity and the size of the FOB are some of the other limitations of the study.

Conclusion

Our study examined the hemodynamic responses to

NTI using an FOB or a DLS in anesthetized children. Hemodynamic responses and adverse events were fewer in the FOB group than the DLS group who underwent NTI; thus, FOB-guided NTI can be safely used in children who are undergoing outpatient dental surgery. For NTI, we believe that FOB will be more successful than DLS. However, alternative methods should be tested for NTI in children because of longer intubation times and studies are needed in this regard.

Ethical approval

Inonu University Medical Faculty Hospital Ethics Committee Confirmation 2015/101.

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Nil.

Conflicts of interest:

There are no conflicts of interest.

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