

Bedside Estimation of the Length of Nares-Vocal Cord in Children

Young Eun Lee, Teo Jeon Shin*, Chong-Chul Kim*, Sang-Hoon Lee*, Ki-Taeg Jang*, Jung-Wook Kim*, Young-Jae Kim*, Hong-Keun Hyun*, Hyojo Han, Hyun Jeong Kim, and Kwang-Suk Seo

Department of Dental Anesthesiology and Dental Research Institute, *Department of Pediatric Dentistry, School of Dentistry, Seoul National University, Seoul, Republic of Korea

Abstract

소아에서의 비공 - 성대간 거리에 관한 예측공식의 유도

서울대학교 치의학대학원 치과마취과학교실, *서울대학교 치의학대학원 소아치과학교실

이영은 · 신터전* · 김종철* · 이상훈* · 장기택* · 김정욱*
김영재* · 현홍근* · 한효조 · 김현정 · 서광석

배경: 협조가 불가능하거나 진정법 하 치과치료가 여의치 않을 경우 전신마취 하 치료를 계획하게 된다. 하지만 전신마취 하 치료시 기관내 삽관이 여의치 않은 경우를 종종 경험하게 된다. 이와 같은 경우 기관지경을 이용한 기관내 삽관을 시행한다. 기관지 내시경을 환자의 성문에 근접하게 전진시킬 경우 기관지 내시경 하 시야확보가 용이한 점을 감안 시 비공 - 성대간 거리를 예측하는 것은 매우 유용할 것으로 생각된다. 또한 비공 - 성대간 거리를 추정하게 되면 맹목적 비강내 기관내 삽관을 하는데도 도움이 된다.

방법: 본 연구는 전신마취하 치과치료가 예정되어 있는 62명의 소아환자들을 대상으로 하여 신체변수와 비공 - 성대거리와의 관계를 확인해보고자 하였다. 선형회귀분석을 시행하여 다음과 같은 결론을 도출하였다.

결과: 소아환자들에 있어 비공 - 성대간 거리는 환자의 신장, 체중, 연령 등과 상관관계를 나타내었다. 비공 - 성대간 거리와 상관관계를 보인 변수들 중 에서 신장과의 상관계수가 가장 높았다. 선형회귀분석을 통해 비공 - 성대간 거리를 예측하는 다음과 같은 회귀식을 구하였다.

$$\text{비공 - 성대간 거리} = (4.8 + \text{신장(cm)}) \times 0.07$$

고찰: 본 연구에서 구해진 회귀식을 이용하여 기도유지가 어려운 소아의 기도유지 하는데 큰 도움이 될 것으로 생각된다. (JKDSA 2011; 11: 141 ~ 145)

핵심용어: Child; Endoscopes; Intubation

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Corresponding author: Kwang-Suk Seo, Department of Dental Anesthesiology, Seoul National University School of Dentistry, 28 Yeongeon-dong Jongno-gu, Seoul 110-768, Republic of Korea
Tel: +82-2-2072-0622, Fax: +82-2-766-9427
E-mail: stone90@snu.ac.kr

* Young Eun Lee and Teo Jeon Shin equally contributed to this study.

INTRODUCTION

Nasal intubation is preferred for dental surgery. The nasal route provides an excellent surgical access. However, nasal intubation by conventional laryngoscope is not always possible. In this situation, the fiberoptic

bronchoscope via nasal route can be helpful. Rail-roading the fiberoptics through the endotracheal tube (ETT) can guide it to the glottis (Machata et al, 2003a). However, placing ETT too shallow or deep may disturb fiberoptic intubation. Keeping in mind that glottic visualization may be facilitated as bronchoscope approaches near the epiglottis, it is important to know the nares - vocal cord length (NV length). Moreover, prediction of NV length can be useful for performing blind nasal intubation in the urgent situation (Weitzel et al, 2004) and proper positioning of ETT (Freeman et al, 1995). Blind nasal intubation is widely attempted to ensure the airway in patients with respiratory difficulty.

Several formulas to predict NV length in the adults have been suggested (Stoneham, 1993; Han et al, 2005). However, the formula for NV length prediction has not been suggested in children yet. Therefore, we aimed to investigate the relationship of NV length between the body parameters in children.

MATERIAL AND METHODS

After obtaining IRB approval and informed consent, 62 ASA 1-2 pediatric patients under the age 15 yr, who underwent dental treatment under general anesthesia requiring nasotracheal intubation, were enrolled. The patients with bleeding tendency, severe nasal deformity, and anatomical defects of the airway were excluded from the study. The demographic data including height, weight, age, and sex was preoperatively recorded.

No premedications were administered. Routine monitoring, such as electrocardiogram, pulse oximetry, and non-invasive blood pressure, was applied to the patients. The patients were placed in the sniffing position. Anesthesia was induced using thiopental 5 mg/kg with vecuronium 0.1 mg/kg IV. The patients were ventilated with 7-8 vol % sevoflurane in 100% O₂ via a facial mask. The selection of the endotracheal tube (ETT) was done using the formula for pediatric patients (inner diameter of tube size = age (yr)/4 + 3) (Duracher et al, 2008). The distance from

Table 1. Demographic Data

	Male (n = 36)	Female (n = 26)
Age (yr)	10.2 ± 2.9	10.6 ± 3.3
Height (cm)	141.8 ± 29.7	141.8 ± 17.9
weight (kg)	41.4 ± 15.8	38.3 ± 13.1
NO length (cm)	11.2 ± 1.2	11.1 ± 1.2
NV length (cm)	15.6 ± 1.7	15.3 ± 1.5

distal tip was marked on the preselected tube using the ruler. The selected ETT was sterilized with the autoclave preoperatively. Nasotracheal intubation was standardized throughout the experiment. The experienced anesthesiologists (K-S, Seo, H-J. Kim) who performed more than 5000 nasotracheal intubations intubated the patients to reduce the intubator related bias. Nasotracheal intubation was performed after muscle relaxation evaluated by neuromuscular monitoring was fully achieved. The tube was first inserted into the most suitable nostril as previously described (Lee et al, 2005). The laryngoscope was inserted to expose the best laryngeal view with the neck extended. Distal tip of ETT was advanced to be placed between the vocal cords. At this point, the nurse who was blinded to our study measured the distance marked on ETT at the nares. These values were considered as NV length. After measurement, ETT was advanced to be placed in the mid-trachea using auscultation method (Bloch et al, 1988). Anesthesia was maintained with 50% N₂O/O₂ and sevoflurane throughout the surgical procedures.

The demographic data was compared with student t-test. A linear - regression analysis was used to find the relationships of NV length between body parameters (height, age, weight, and sex). A P < 0.05 was considered to be statistically significant.

RESULTS

The demographic data was shown in Table. 1. The height, age, weight, and NV length was not statistically different between the sexes. The mean NV length was 15.6 ± 1.7 in male, 15.3 ± 1.5 in female,

respectively.

Pearson correlation analysis showed that there was a significant correlation between NV length and age, height, and weight ($P < 0.001$). The correlation between NV length and sex was not statistically significant. Among the variables included in the regression analysis, the pearson's coefficient between NV length and height was the highest ($r = 0.874$). The correlation coefficient was 0.802 and 0.764 in NV length versus age and weight, respectively.

We estimated the regression formula for NV length using the height with the highest pearson's coefficient among tested. The regression formula for NV length was the NV length = $4.8 + \text{height (cm)} \times 0.07$ ($r = 0.874$, $P < 0.001$).

Next, we performed a regression analysis by including the other body parameters (weight and age) which showed a significant correlation with NV length in a stepwise fashion to investigate whether to improve the predictability of the formula significantly. The r -value was only increased from 0.874 to 0.875 when both parameters (age and weight) were included in the analysis. The increase in r -value with inclusion of parameters was not statistically significant ($P = 0.510$).

From the regression analysis, we estimated the formula to predict NV length in children as follows. NV length (cm) = $4.8 + 0.07 \times \text{height (cm)}$ (Fig. 1)

DISCUSSION

According to the results in this study, NV length was significantly correlated with the height in children. From our results, we suggest formula using the height to estimate NV length. It is very interesting that Han et al have demonstrated a significant correlation of NV length between the body height in adults in line with our results (Han et al, 2005). However, the correlation coefficient ($r = 0.874$) of our formula is far higher compared to the values ($r = 0.755$) described by Han et al. This indicates that our formula show a higher capacity to predict NV length

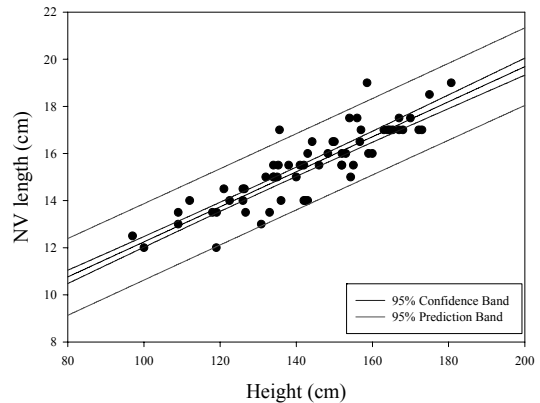


Fig. 1. Relationship between the nares-vocal cord length (NV length) and the height in children. The regression formula is NV length = $4.8 + \text{height (cm)} \times 0.07$. ($r = 0.874$, $P < 0.001$) The regression line with 95% confidence intervals (blue solid line) is also shown with 95% prediction intervals (red solid line).

in children.

In our study, we found a significant correlation of the weight and age between NV length as well as the body height in children. However, the inclusion of these parameters did not improve the predictability of the formula significantly. Therefore, we obtained the regression formula of NV length based on the height. In previous studies, anthropometric parameter such as the nare - to the tragus of the ear distance (Stoneham, 1993; Han et al, 2005), was attempted to predict NV distance. However, these parameters are somewhat cumbersome to measure before anesthetic induction and not easily applicable. The formulas suggested by us involves only one parameter (height), which are easily obtained in medical record on admission for surgery. Also, the formula using body parameter is easy to be used. Thus, our formula could be easily used in clinical practice for estimating NV length in children.

From the perspective of the laryngeal view, nasal route during fiberoptic endotracheal intubation is preferred (Machata et al, 2003b). Two ways is possible to advance the bronchoscope into the nasopharynx

during fiberoptic intubation. The intubator either inserts the fiberoptics into the nostril to serve a guide for advancing the endotracheal tube or this into the nasopharynx to serve as guiding the bronchoscope. In children, posterior pharyngeal space where manipulation performed is relatively small and limited (Rucker et al, 1979). In this aspect, placing nasal ETT prior to entering the scope into the posterior pharynx may be more suitable in that the tube can guide the scope to the larynx in children. However, placing the tube too shallow may locate the bronchoscope inside the nasal cavity, making it difficult to provide the best laryngeal view, whereas placing it too deep may disturb manipulating the scope. In this sense, predicting how far ETT is advanced near the vocal cord is important for nasal fiberoptic intubation, especially when the tube served as guiding the bronchoscope. It is generally thought that manipulating the bronchoscope to visualize the laryngeal aperture may work well when the distal tip of the bronchoscope is placed in posterior pharynx, upper from the vocal cord. Thus, our results suggest the extent of ETT advancement for facilitating nasotracheal fiberoptic intubation.

In a study conducted by Freeman et al, they propose insertion depths of nasal ETT beyond the vocal cords for proper positioning in accordance with tube diameters (3 cm for tubes with a diameter 3 or 3.5 cm, 4 cm for tubes with a diameter of 4 or 4.5 cm, 5 cm for tubes with a diameter of 5 or 5.5 cm) in children (Freeman et al, 1995). Thus, our formula also suggests ideal depth of nasal ETT in children. From our results, the ideal depth of nasal ETT is calculated by merely adding the predicted NV length to the aforementioned values proposed by Freeman et al in accordance with the diameter of the tube. Our formula may be used as alternative methods to predict the ideal tube depth in children.

In addition, our formula could be also used to estimate the proper length of tube advancement for blind nasal intubation. Blind nasal intubation can be used to secure the airway in children with limited

mouth opening (Acharya, 2008) and maxillofacial injury (Walls and Facep, 1998). Moreover, blind nasal intubation could be effectively employed in deep sedated pediatric patients with respiratory difficulty. In spontaneous breathing patients, navigating ETT to the place where the maximal breath sounds are achieved can be helpful in performing blind nasal intubation (Danzl and Thomas, 1980; Iserson, 1981). It is highly likely that advancing ETT near the vocal cord increase the likelihood of obtaining the maximal breath sound. In this sense, our formula would be very useful to facilitate intubation in spontaneous breathing children when blind nasal intubation is attempted.

However, our study has several limitations. First, a ruler should be needed to measure the indicated length in commercially available ETT. Therefore, we recommend the manufacturer of pediatric nasotracheal tube to extend the depth marker permitting to advance ETT to the predicted NV length from our formula, not usually marked in commercially available nasal ETT, without using a ruler. Second, clinical application of our formulas is limited to older children, not neonate and young children (< 3 yr).

In conclusion, we have shown that NV length is significantly correlated with the body height in children.

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