Assessment of Endotracheal Tube Position After Oral Intubation in Neonates

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ABSTRACT

Aim: Endotracheal intubation is a common procedure in the delivery room and neonatal intensive care unit. We aimed to determine the accuracy of this method of endotracheal tube (ETT) placement in our neonatal cohort.

Materials and Methods: Data on infants requiring oral intubation were reviewed retrospectively. The initial ETT depth of insertion had been calculated using the Tochen 7-8-9 rule. The initial depth was compared to the mid-tracheal region. The differences between the initial and ideal depth was calculated and divided by the mid-tracheal distance. Infants were grouped according to their weights as ≤1000 g, 1001 to 2000 g, 2001 to 3000 g and ≥3001 g.

Results: We evaluated ETT placement in 160 neonates. The mean gestational age was 32.2±4.4 weeks (23 to 41 weeks) and the mean weight was 1989±829 g (560 to 3800 g). The mean range of the difference between the initial depth and ideal depth divided by mid-tracheal distance was 0.39±0.04, 0.35±0.04, 0.46±0.05, and 0.23±0.04 in infants weighing ≤1000 g, 1001 to 2000 g, 2001 to 3000 g and ≥3001 g respectively (p=0.025). The differences between the 2001-3000 g group and the 1001-2000, also the 2001-3000 g group and the ≥3001 g group were statistically significant (p<0.05).

Conclusion: The 7-8-9 rule should be used to assess ETT length in neonates, especially in those weighing more than 3 kg. As this rule has low accuracy for extremely low birth weight neonates, its reliability may not be high for neonates weighing less than 3 kg in weight.

Keywords: Endotracheal intubation, neonates, Tochen’s rule, resuscitation, position of the tube

Introduction

Respiratory problems requiring endotracheal intubation are common during the neonatal period and occur extensively in neonatal practice. Endotracheal intubation is a common procedure in the delivery room and neonatal intensive care unit (1,2). As the tube malposition is associated with hypoxemia, pneumothorax, right upper lobe collapse and death, rapid confirmation of proper tube placement is critical (3). The correct position of the endotracheal tube (ETT) tip is the mid-tracheal area. However, the success rate of correct ETT placement for junior medical staff is less than 50%, and accidental esophageal intubation is common (4). The incidence of malposition for the placement of ETT can be as high as 50% (5). Pediatric resident trainees are currently not provided with adequate guidance to ensure the development of competency in neonatal intubation (4). Proficiency at intubation in controlled circumstances requires 40 or more procedures (6). Previously, the 7-8-9 rule was described by Tochen (7) and recommended by
the American Academy of Pediatrics (2) to determine the depth of ETT insertion. Although this rule is frequently used in neonatal practice, studies about its accuracy are inadequate. Using gestational age can be useful especially when infants are intubated in the delivery room. Despite this, although gestation information is usually both accurate and available, the baby will not have not been weighed (8). X-ray chest radiography is the gold standard procedure available to determine the tube position; however, this is often delayed until after ventilation has initiated. Therefore, a number of rapid point-of-care methods (e.g., clinical signs, exhaled carbon dioxide (CO₂) detectors, respiratory function monitors and ultrasound) to confirm the correct tube placement have been developed (3). Nasal-tragus length (NTL) to predict the optimal ETT depth with the formula, NTL plus 1 cm, has been suggested as clinically practical for newborn infants (9). In our country, NTL is currently used under the Neonatal Resuscitation Program (NRP) recommendations (10). Foot length has been suggested as a reliable and reproducible predictor of nasotracheal tube length (11). Clinical findings of accurate tube placement include an increase in heart rate, adequate chest wall movements, auscultation of breathing sounds in the axillary and an absence of sounds in the epigastric region (12). We conducted this study between 2013 and 2014, the period before the introduction of the NTL in the NRP guidelines in Turkey. We aimed to determine the accuracy of this method in the prediction of the optimal ETT depth in our neonatal cohort. Hence, we might contribute to studies on the estimation of accurate ETT depth.

**Materials and Methods**

The data of infants requiring oral intubation from March 2013 to December 2014 were reviewed retrospectively. The subjects’ demographic and clinical data were collected retrospectively from hospital records. Infants with congenital anomalies that complicated the intubation procedure were excluded. The intubation had been performed by a supervised pediatric resident or a neonatologist in accordance with guidelines. The intubation time and intubation place were collected. Because of the retrospective nature of this study, it is outside the scope of the ethics committee, and so we did not apply to ethics committee. In addition to that, we did not disclose any patient information in accordance with the Helsinki declaration.

**Statistical Analysis**

Data were obtained regarding the arithmetic mean and standard deviation. Independent Samples-t or ANOVA tests were used to compare the variables between groups. A p value <0.05 was considered significant. Analyses were performed using SPSS 19 (IBM SPSS Statistics 19, SPSS inc., an IBM Co., Somers, NY).

**Results**

This retrospective cohort study evaluated ETT placement in 160 neonates. The mean gestational age was 32.2±4.4 weeks (23 to 41 weeks) and the mean weight was 1989±829 g (560 to
Thirty-eight infants weighed 1000 g or less, 70 infants weighed 1001 to 2000 g, 50 infants weighed 2001 to 3000 g and 23 infants weighed 3001 g or above. Table I shows the demographic and clinical data of the subjects with the distance of the ETT tip to the mid-tracheal point. The ETT tip was lower than the ideal depth in 51 infants and it was higher in 109 infants. Right bronchus intubation was detected in 23 infants. The mean range of the difference between the initial depth and ideal depth divided by mid-tracheal distance was 0.39±0.17, 0.35±0.30, 0.46±0.38, and 0.23±0.19 in infants weighing 1000 g or less, 1001 to 2000 g, 2001 to 3000 g, and 3001 g or above respectively (p<0.05). The difference between the 2001-3000 g group and the over 3000 g group was statistically significant. Table II shows the values of the ratio in all study groups. The number of infants intubated above the ideal depth was more than twice of the number of infants intubated below the ideal depth (109 infants vs 51 infants). There was no statistically significant difference between birth weight groups and location of ETT in terms of being below or above the ideal depth (Table III).

**Discussion**

There have been various studies to evaluate both the correctness and usefulness of different techniques for ETT placement in neonates. Although one study found flexible fiberoptic bronchoscopy to correlate well with chest radiography (14), another study without chest radiography, concluded that a mathematical algorithm could be used to estimate the depth of ETT insertion and so could help a practitioner perform intubation when radiography is not available (15). All these attempts are to overcome both ETT malposition and its associated complications, while also allowing for rapidly deciding the appropriate ETT insertion length for resuscitation. Despite these techniques and methods, until recently, the Tochen rule was used in neonatal resuscitation practices for assessing depth of ETT insertion. This rule was accepted as useful, safe and effective by some authors (13). In our country, the Tochen rule has not been used since 2015. NTL is in use in accordance with current NRP.
There is no conclusive explanation for this discrepancy, it might be because the intubations were done by different practitioners. When the intubation in neonates are done in an urgent or emergency situation in the NICU or delivery room, it should be performed in the shortest amount of time possible. Therefore, because determining or estimating the weight of the infant may be impossible or at least not accurate, the 7-8-9 rule has been unreliable in determining the ETT length in neonates requiring intubation (13,20). Trained NICU personnel have also been shown to make errors of 22% to 33.6% in weight estimations (21). In addition, it has been suggested that the ETT depth may also be affected by the head position on the chest radiography, some methods have been proposed for correcting this (15). Guidance using the gestational age may be particularly useful in the delivery room, where the gestational age is usually accurate but the newborns have not been weighed yet (8). Kempley et al. (20) determined that the ETT length in neonates was related to gestation in a linear manner, an inconsistency with Tochen’s rule, but the relationship with weight was non-linear. Other methods are based on physical markers like NTL, sternal length or head circumference. These may be faster and more accurate to assess the depth of ETT in neonates (9,22). Because the malposition of the ETT can cause serious complications, the rapid determination of tube placement is a very important goal. For this purpose, however, the gold standard method is currently chest radiography. Despite this, various new techniques have been suggested, e.g., measuring air going in and out of the lung (using a respiratory function monitor) (23), measuring the amount of exhaled CO₂ (1,24), and using ultrasound to image the tube within the windpipe (3). The purpose of this study was to verify our clinical experience and its agreement with the currently available reference values. We believe that these efforts will provide objective and scientific information for the optimal resuscitation of neonates.

**Study Limitations**

There are a few limitations of the present study. Because of the disparity between the practitioners, the accuracy of ETT intubation may be influenced by the skill of practitioners. Another limitation of this study is, because of the retrospectively nature of this study, we do not know how the infant’s weight was estimated or obtained to decide the insertion length of ETT.

**Conclusion**

Based on this study, in neonates who need intubation, particularly for those over 3 kg, the 7-8-9 rule can be used to determine ETT length. Although this rule has been implemented for many years, as it is open to practitioner differences, especially in weight estimation, its accuracy and sensitivity are unclear in newborns less than 3 kg in weight.
Otherwise, the expertise of the practitioners may affect the accuracy of the ETT location.

Ethics

Ethics Committee Approval: Retrospective study.

Informed Consent: Not applicable.

Peer-review: External and internal peer-reviewed.

Authorship Contributions


Conflict of Interest: No conflict of interest was declared by the authors.

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