

## Ultrasonographic Confirmation of Endotracheal Tube Position in Neonates

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**Objective:** To compare endotracheal tube tip-to-carina distance obtained by ultrasonography vs. that obtained by chest X-ray in neonates.

**Methods:** After endotracheal intubation of 40 neonates, chest X-ray and, within one hour, ultrasonography was obtained for each patient for measurement of endotracheal tube tip-to-carina distance.

**Results:** Means of endotracheal tube tip-to-carina distances were not significantly different by both modalities (mean difference 0.157 cm,  $P=0.06$ ). In addition, an intraclass correlation was observed between them ( $r^2=0.61$ , 95% CI= 0.26, 0.79).

**Conclusion:** Ultrasonography and chest X-ray are equally accurate for determination of endotracheal tube tip-to-carina in infants. As ultrasonography is more easily available and is safer than X-ray, it may be a better modality for confirming proper placement of endotracheal tube in neonates.

**Keywords:** Endotracheal intubation, Radiography, Ultrasonography.

Clinical evaluation, radiography, ultrasonography (US), exhaled carbon dioxide detection and bronchoscopy are some methods to diagnose misplaced intubation [1-3]. Schmolzer, *et al.* [4] reported that chest radiography is the gold standard method for endotracheal tube (ET) positioning. However, the toil, the time needed, and X-ray exposure required for radiographic assessment of ETT position have caused investigators to consider whether US could be equally useful in this regard [5-11].

Currently, in our center, chest X-ray is the standard method for the evaluation of the endotracheal tube position. This is obtained following each neonatal intubation (primary or after re-intubation). Considering the potential disadvantages of radiography, we decided to evaluate US as an alternative method for tube localization.

### METHODS

This cross-sectional study was carried out in infants admitted to neonatal intensive care unit (NICU) of Namazee, Hafez and Zeinabiyeh hospitals affiliated to Shiraz University of Medical Sciences, Iran, from May to October 2014. We included all admitted infants who required intubation. Infants whose ETT tip was not clearly visible by any modality were not included in the study.

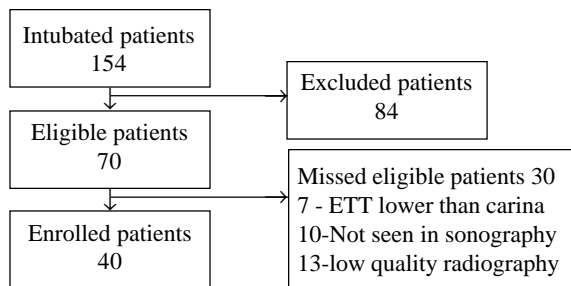
CXR was obtained for each neonate after primary

intubation or re-intubation. Proper site of the ET tip on CXR was defined as below the thoracic inlet and above the carina. All infants underwent portable US (by Teknova TH-5100) within 1h of chest X-ray. Midsagittal views were obtained by a high-frequency linear probe (10 MHz) for evaluation of ET-tip distance from superior portion of the right pulmonary artery, the anatomic equivalent of the carina. US was performed under the supervision of a radiologist or a pediatric cardiologist, by a neonatologist who had been trained for chest sonography for at least 6 months prior to the time of the study. All operators were unaware of the result of radiographic assessment of ET position. The ET could be moved in and out about 2 mm for better visualization of the tip position. The distance of ET-tip to carina on chest X-ray was measured by a radiologist who was blinded to sonographic findings. The time required to obtain both the investigations was recorded for each patient.

This study was approved by Institutional ethical committee of Shiraz University of Medical Sciences. SPSS (V.16) was used for statistical analysis.

### RESULTS

A total of 154 infants were admitted and intubated in the NICU during the 6 month study period. Of the 70 eligible patients, thirty were excluded from the study due to ET tip



**FIG. 1** Flow of patients in study.

lower than the carina (7 patients) or ET tip higher than the thoracic inlet (10 patients), and improper radiography technique (13 patients) (**Fig. 1**). Forty infants (24 males) were finally enrolled. Mean (SD) age of included infants was 16 (17) days (median: 8 d, range: 1 to 64 d). Seven patients who had chronic lung disease (17.5%) were beyond neonatal age. Mean (SD) weight and length were 2037 (924) grams and 42.5 (6.6) cm, respectively.

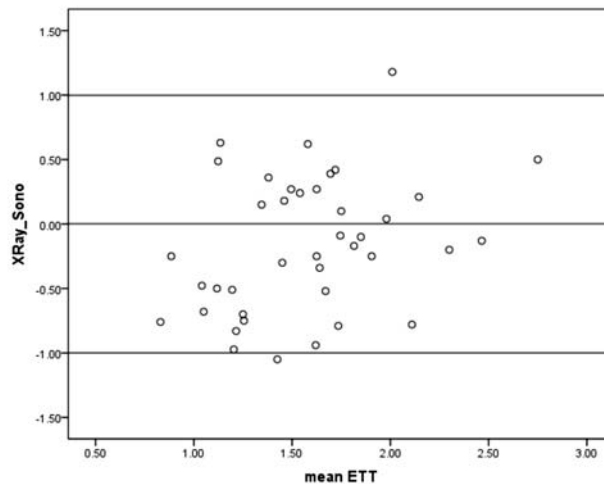
Mean (SD) distance of ET tip-to-carina (or RPA) was 1.49 (0.5) and 1.65 (0.4) centimeters on CXR and US, respectively. Differences between ET tip-to-carina values measured by radiography versus those obtained by US were not significant (mean difference 0.157 cm,  $P=0.067$ ). An intraclass correlation (ICC) was observed between ETT tip-to-carina distance on US and CXR ( $r^2=0.61$ , 95% CI= 0.26, 0.79) displays the Bland-Altman plot of ET-to-Carina distance as measured by two methods ( $r^2=0.314$ ).

Mean (SD) time interval between intubation and radiographic evaluation was 2 (1) hours while the required time for US assessment was less than 5 minutes.

## DISCUSSION

Identification of an appropriate method for evaluation of ET position is very important; finding a fast and simple method should be considered necessary. Results from this study showed that both US and chest X-ray have similar accuracy in evaluation of ET tip-to-carina distance.

Although some previous studies imply that chest X-ray is a good method for evaluation of ET positioning [7,12] others have proposed that US is even better for this purpose [8-11,13]. Dennington, *et al.*[7] showed that bedside US has a relatively good correlation with radiography ( $r^2=0.68$ ) which is comparable with our study. We observed an accuracy of 100% in detection of ET tip by sonography. This study also provided evidence of considerable time advantage of US over chest X-ray. Data from a majority of studies in this field is in agreement with our study [4,8,13-15].



**FIG. 2** Bland-Altman plot of distance measured by sonography versus radiography between endotracheal tube and carina.

Our study has limitation of a small sample size. Time interval between radiography and sonography was up to 1 h; a shorter interval would have produced more valid results.

In conclusion, US and chest X-ray are equally accurate for determination of ET tip-to-carina in neonates requiring endotracheal intubation. As US is more easily available and is faster and safer than X-ray, may be considered a better modality for this purpose.

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**WHAT THIS STUDY ADDS?**

- Ultrasonography is a valid method for the assessment of endotracheal tube tip position in neonates.

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