RESEARCH PAPER

Ultrasound-Guided Assessment Of Subglottic Diameter To Predict Appropriate Endotracheal Tube Size In Paediatric Patients Undergoing Cleft Lip And Palate Surgery: A Prospective Randomised Study

Dr. Akshata Aravind Kulkarni[1*], Dr. Rajesh Mane[2]

[1*] Assistant Professor, Department Of Anaesthesiology, Kaher Jgmmmc Hubballi, India.
Email: akulkarni9390@gmail.com

[2] Professor, Department Of Anaesthesiology, Kaher Jnmc Belagavi, India.

Corresponding Author: Dr. Akshata Aravind Kulkarni, Assistant Professor, Department Of Anaesthesiology, Kaher Jgmmmc Hubballi, India. Email: akulkarni9390@gmail.com

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Abstract

Background: Selection of an appropriately sized endotracheal tube (ett) in paediatric patients remains challenging due to anatomical variability, especially in children with cleft lip and palate. Ultrasonographic measurement of subglottic diameter offers a patient-specific alternative to traditional formula-based methods.

Methods: Sixty children aged 1–6 years (asa i–ii) undergoing cleft lip and palate repair were randomised into two groups: group a (modified cole's formula) and group b (ultrasound-guided selection). The primary outcome was correct ett size based on an air leak between 10–30 cmh$_2$o. Statistical analysis included chi-square testing, confidence intervals, and bland–altman agreement analysis.

Results: Correct ett size was achieved in 80% of group a and 96.7% of group b (absolute difference 16.7%, 95% ci: 2.3–31.1%, p=0.04). Ultrasound significantly reduced tube exchanges and demonstrated improved agreement with clinically optimal tube size.

Conclusion: Ultrasound-guided assessment improves the accuracy of ett size selection and reduces airway manipulation in paediatric patients with cleft lip and palate.

Keywords: Na

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INTRODUCTION

Airway management in paediatric patients presents unique challenges due to anatomical and physiological differences compared with adults. The paediatric airway is narrowest at the subglottic level, making this region critical in determining appropriate ETT size.[1,6]

Age-based formulae such as Cole's formula are widely used but do not account for individual variability.[3] This limitation is amplified in children with cleft lip and palate, where airway anatomy is altered.[15]

Ultrasound allows direct visualisation of airway structures and measurement of subglottic diameter, offering a more accurate and individualised approach.[1,8]

This study compares ultrasound-guided ETT selection with the modified Cole's formula in this high-risk population.

METHODS

Study Design and Sample Size

Prospective randomised controlled study with ethical approval and informed consent. Based on expected 20% improvement, 30 patients per group were included.

Randomisation

Computer-generated allocation into:

- Group A: Modified Cole's formula
- Group B: Ultrasound-guided

Anaesthesia and Ultrasound

Standard anaesthesia protocol followed. Ultrasound performed using a high-frequency linear probe at the cricoid level to measure subglottic diameter.[19]

Outcomes

Primary: Correct ETT size (air leak 10–30 cmH$_2$O)

Secondary: Tube exchange, ventilation adequacy, complications

Statistical Analysis

- Chi-square/Fisher's exact test for proportions
- Independent t-test for continuous variables
- 95% confidence intervals
- Bland–Altman analysis for agreement
- $p < 0.05$ considered significant

RESULTS

Demographics

No significant differences between groups.

Primary Outcome

- Group A: 24/30 (80%)
- Group B: 29/30 (96.7%)
- Absolute difference: 16.7%
- 95% CI: 2.3–31.1%
- $p = 0.04$

Secondary Outcomes

- Tube exchanges: Higher in Group A
- Air leak pressures: More optimal in Group B
- Ventilation: More consistent in Group B
- Complications: No significant difference

Bland–Altman Analysis

Ultrasound group showed reduced bias and narrower limits of agreement, indicating superior predictive accuracy.

DISCUSSION

Ultrasound significantly improves accuracy of ETT selection compared to formula-based methods.

The **statistical significance (p=0.04)** combined with **clinically meaningful effect size (16.7%)** supports its superiority. Confidence intervals confirm robustness of findings.

Bland–Altman analysis strengthens the conclusion by demonstrating improved agreement rather than just proportion-based success.

These findings align with previous studies supporting ultrasound as a superior modality.[1,8,9]

CONCLUSION

This prospective randomised study demonstrates that ultrasonographic measurement of the subglottic diameter provides a significantly more accurate and clinically reliable method for selecting endotracheal tube size in paediatric patients undergoing cleft lip and palate surgery when compared with conventional age-based formulae. The observed improvement in correct tube selection, coupled with a reduction in tube exchange rates, underscores the value of a patient-specific, anatomy-driven approach to airway management in this high-risk population.

Importantly, ultrasound not only enhances first-attempt success but also minimises repeated airway instrumentation, which is particularly relevant in children with craniofacial anomalies who are predisposed to difficult airway management and postoperative airway oedema. The tighter agreement demonstrated on Bland–Altman analysis further reinforces the superior predictive performance of ultrasound over formula-based estimations.

From a clinical perspective, the integration of point-of-care airway ultrasonography into routine paediatric anaesthetic practice has the potential to improve perioperative safety, optimise ventilation, and reduce airway-related morbidity. Although operator dependency and the need for training remain considerations, the technique is non-invasive, reproducible, and readily adoptable in modern operating settings.

Future research should focus on larger multicentre trials, inclusion of diverse paediatric subpopulations, and evaluation of learning curves to facilitate broader implementation. Nonetheless, based on the present findings, ultrasound-guided ETT selection represents a meaningful advancement towards precision airway management in paediatric anaesthesia.

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