

Pediatric Airway shape; What has changed, and the implications?

Airway shape in infants and children has been defined as “funnel-shaped with the cricoid cartilage as the narrowest point in the airway.” The funnel shape of the pediatric airway was cited from an article by Eckenhoff.¹ Eckenhoff's description of the pediatric larynx was based on cadaveric airway research by Bayeux, (1897),² which was quoted only partially by Eckenhoff. Eckenhoff did caution that “the measurements so derived may not be completely applicable to the living.”

Bayeux used calibrated cylinders separately at three points in the airway, cricoid trachea, and glottis, and concluded that the cricoid was the narrowest part of the airway, this part of his research was reported by Eckenhoff. Bayeux also obtained airway castings, which showed that on an anteroposterior section, the narrowest part of the larynx is the cricoid and whereas in lateral view (transverse sections) these relations are inverse with glottis narrower than the cricoid. This important observation that the airway dimensions in anteroposterior and transverse sections looked different, with airway conical or funnel-shaped in the sagittal sections and reverse of it in the anteroposterior sections has been continuously overlooked in the literature and was not reported by Eckenhoff.

The concept of funnel-shaped pediatric airway held its ground over years but has been challenged in recent years with modern imaging technologies (CT, MRI, and Ultrasound) replacing the cadaveric anatomical descriptions of the airway shape. Litman et al.³ described the larynx as a reverse cone with the apex of the cone at the level of the vocal cords in the transverse dimension and cylindrical in the AP diameter using magnetic resonance imaging scans to study the laryngeal dimensions in neonates to 14-yr-old children. Litman wrote that measurements

derived from cadaver specimens could be distended in the portions of the larynx cephalad to the cricoid ring since these areas do not contain full circumferential cartilage. Litman measured a paralyzed but tonically active larynx, studying the dimensions in alive, breathing children seems to be clinically more relevant and plausible. Dalal et al.⁴ video-bronchoscopy to define the cross-sectional area of the airway in 128 infants and children during general anesthesia and neuromuscular blockade.⁴ The study concluded that the pediatric larynx was cylindrical rather than funnel-shaped and there was no age-based transition from a pediatric to the adult larynx. Their findings were in line with the findings of Litman et al.

We reported multiple studies on the shape of the pediatric airway using 2-dimensional and 3-dimensional CT images in spontaneously breathing patients.⁵⁻⁷ The three-dimensional CT study, which included 54 patients ranging in age from 4 months to 10 years, was designed to provide data to compare to Bayeux's work using 3-mm slices of the air column measured at the level of the subglottis, cricoid, and trachea (Figure 1). The authors postulated that the three-dimensional air column represents the bougies of Bayeux while providing a more precise and realistic anatomical view of the airway eliminating the bias of the cadaveric airway. The findings were similar to Litman et al., and Dalal et al., showing that the subglottic region is the narrowest portion of the airway, whereas the volumes of the cricoid and tracheal regions were comparable.

This new research describes the pediatric airway in detail and has questioned the validity of the conical or funnel-shaped pediatric airway. These recent studies have shown that the subglottic region (transverse diameter) is the narrowest dimension of the pediatric airway, it being distensible however allows easy passage of an endotracheal

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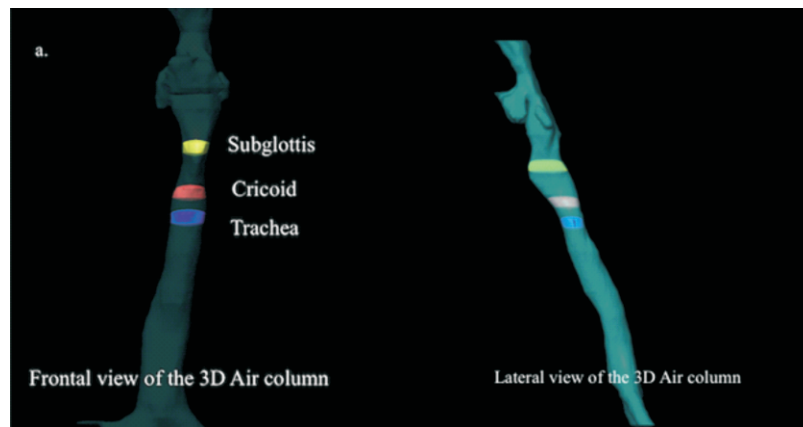


Figure 1: Frontal and lateral view of the air column inside the airway

tube. The gentle distension of the glottic region by endotracheal tube may not be entirely without risk, especially with long-term endotracheal intubation. Therefore, a 'gentle dilatation' of the clinical and anatomical narrow part of the glottis cannot be considered a benign maneuver. The cricoid ring on the other hand is a complete ring and rigid structure and thereby likely provides the greatest resistance to the passage of an endotracheal tube.

These findings question the utility of uncuffed pediatric endotracheal tubes in children. The practice of pediatric anesthesia has changed with new research favoring the use of cuffed endotracheal tubes right from neonates to any age. However, high intracuff pressure has been implicated in mucosal injury due to pressure at the cricoid and subglottic regions. The precise location of the ETT cuff inside the airway has not been defined. There are no techniques or real-time imaging available to locate the ETT cuff concerning the cricoid in children following endotracheal intubation. Further studies in this regard will help better understanding the cuff location and defining the ideal cuff position in the airway.

An evolving understanding of the pediatric airway size and shape has clinical implications to the anesthesia and ICU practice concerning the safe use of cuffed endotracheal tubes. The design and the location of the endotracheal tube cuff will go a long way to make endotracheal intubation safer and prevent injuries to the pediatric airway. The full spectrum of modern technologies must be used to resolve controversies regarding the precise shape of the pediatric airway and address discrepancies arising from different methodological approaches to this problem.

References:

1. Eckenhoff JE. Some anatomic considerations of the infant larynx influencing endotracheal anesthesia. *Anesthesiology* 1951; 12:401-410.
2. Bayeux. Tubage de larynx dans le croup. *Presse Med* 1897; 6:29-33.
3. Litman RS, Weissend EE, Shibata D, Westesson PL. Developmental changes of laryngeal dimensions in unparalyzed, sedated children. *Anesthesiology* 2003;98:41-5.
4. Dalal PG, Murray D, Messner AH, Feng A, McAllister J, Molter D. Pediatric laryngeal dimensions: an age-based analysis. *Anesth Analg* 2009;108:1475-9.
5. Wani TM, Bissonnette B, Malik MR, Ramesh A, Hayes D, Al Sohaibani M, Tobias JD. Age-based analysis of pediatric upper airway dimensions using computed tomography imaging. *Pediatr Pulm* 2016;51:267-71.
6. Wani TM, Rafiq M, Akhter N, AlGhamdi FS, Tobias JD. Upper airway in infants a computed tomography-based analysis. *Pediatric Anesthesia* 2017; 27:501-505.
7. Wani TM, Rafiq M, Talpur S, Soulami L, Tobias JD. Pediatric upper airway dimensions using three-dimensional computed tomography imaging. *Pediatric Anesthesia* (Accepted Jan 2017).

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